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THE ARGENTINE ARMORED CRUISER "GENERAL BELGRANO."

THE handsome and highly efficient armored cruiser herewith illustrated will possess especial interest, owing to the fact that she is practically a sister ship to the ill-fated "Christobal Colon." She is one of seven similar ships which have been built or are now building in the Italian yards of Orlando, at Leghorn, or at the Sestri Ponenti yards.

It would be difficult to find any class of ships in which, on a given displacement—something under 7,000 tons—so many excellent features are combined. They all have high speed, excellent armor protection, an extremely heavy battery, and good sea-keeping qualities.

The "General Belgrano" differs from the "General San Martin" and the "Christobal Colon" in having four 6-inch guns on the main deck, in place of six 4·7-inch guns.

The other ships of the seven referred to are the "Giuseppe Garibaldi" and the "Varese," building for the Italian government; the "Garibaldi" and "San Martin," built for the Argentine Republic; and the "Christobal Colon" (now a wreck upon the Cuban coast) and the "Pedro d'Aragon," built for the Spanish government.

The dimensions of the "General Belgrano" are as follows, viz.:

Length between perpendiculars	328 ft.
Beam	60 ft. 10 in.
Depth moulded	40 ft.
Mean normal draught	23 ft. 3½ in.
Displacement	6,882 tons.

The steel hull has a double cellular bottom, divided in numerous watertight compartments. Protection is afforded at the load water line by a continuous armored belt of 6 inches maximum thickness. The armored deck is 1½ inches thick. The side armor amidships extends to the main deck, and, with the bulkheads, forms a complete armored citadel in which is carried the whole of the 10-inch and 6-inch battery.

The armor, which is of nickel steel, was manufactured at Terni, by the special process of cementation of the Terni Steel Works.

The armament of the "General Belgrano" consists of: Two 10-inch Armstrong guns, mounted in barbette on the main deck, one at each end of the redoubt; ten 6-inch Armstrong rapid-firers, placed in battery within the redoubt on the gun deck; four 6-inch Armstrong rapid-firers on the main deck, capable to fire on the keel line; two 3-inch Vickers-Maxim rapid-fire guns on main deck; ten 2¼-inch Armstrong rapid-firers; eight 1½-inch Maxim guns, besides two landing mitrailleuses of Mauser rifle caliber; two 3-inch Maxim-Nordenfelt guns; four torpedo tubes, placed at the two sides of the lower deck. The ammunition service is performed with great regularity by electric and hand elevators, similar in type to those of the "General San Martin," also built by this firm.

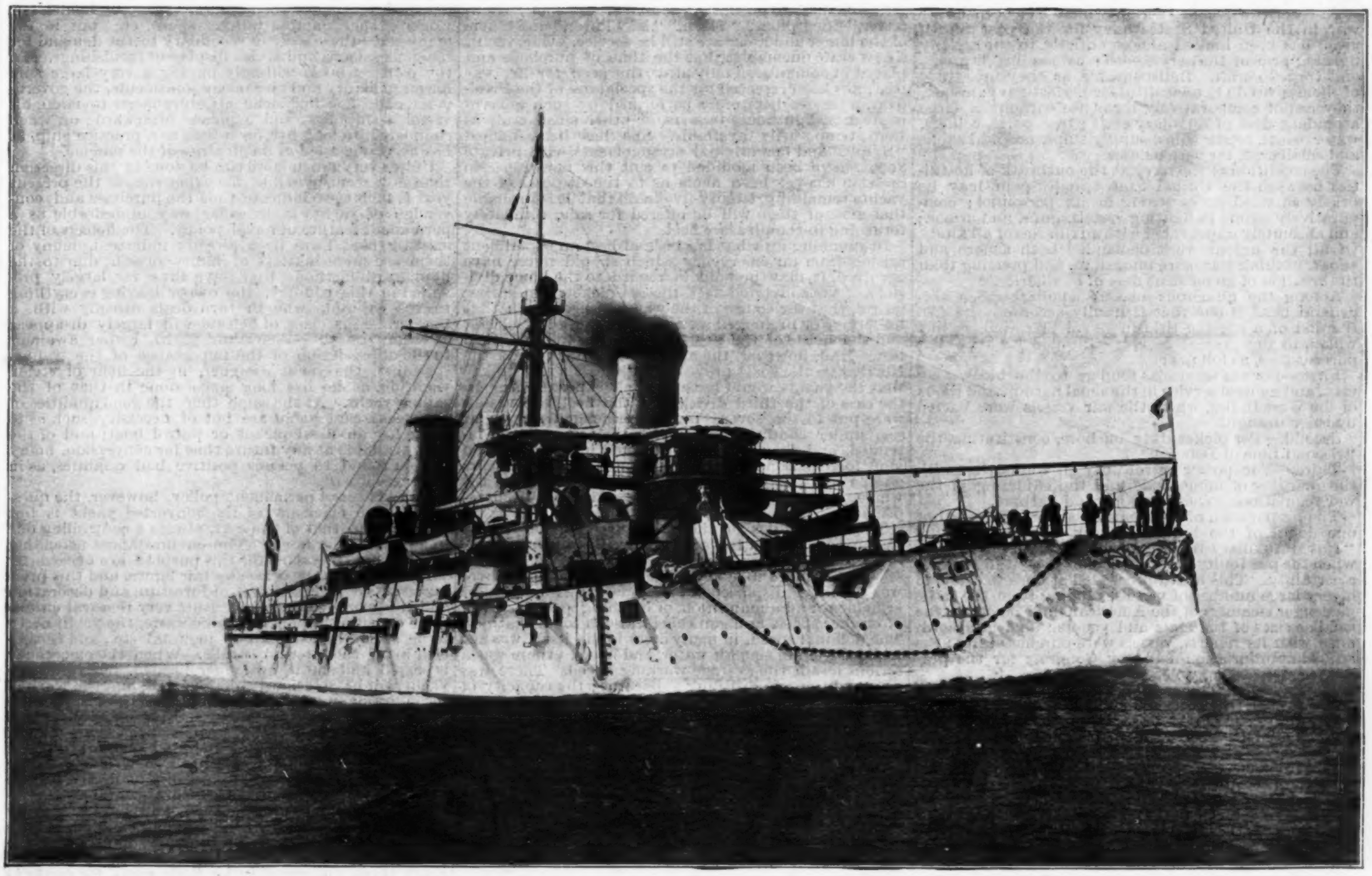
The propelling machinery consists of two triple expansion engines and eight cylindric boilers, divided into two groups, arranged forward and aft in the engine rooms. The engines develop 8,600 indicated horse power at natural draught and 13,000 indicated horse power at forced draught. The total capacity of the bunkers is of about 1,100 tons.

An important electric plant provides for the electric lighting and ventilation. The capstans and ammunition hoists are also worked electrically. There are five searchlights, four of 60 cm., situated on the bridge, and one of 75 cm. in the tops.

In all the machinery trials the results were most satisfactory. The gunnery trials, carried out on the 22d September last (at the same time as the natural draught speed trials), were designed to test the mounting of the pieces and the solidity of the decks and framing of the hull. They were eminently satisfactory, so much so that not even the slightest damage resulted either from the single firing of individual guns or from the simultaneous electric firing of the five 6-inch guns on the port side of the battery.

The speed trials, which lasted six hours, took place on the Scoglio Ferale-Torre Guardiola course, which is 2·2 miles in length. The "General Belgrano," on a mean draught of 23 feet 9½ inches and a displacement of about 300 tons in excess of the normal one, maintained a mean speed of 18·09 knots, with 92 mean revolutions. The forced draught speed of this ship is 20 knots an hour.

The "General Belgrano" was laid on the blocks in June, 1896, and was launched on July 25, 1897. The work, interrupted almost entirely for seven months, owing to delay in the delivery of the propelling machinery, was resumed in March and actively continued in the month of May last, when the first delivery of machinery commenced to be mounted; so that it can be said that the complete construction of this ship has been virtually achieved in the short space of eighteen months.



ARMORED CRUISER "GENERAL BELGRANO"—BUILT FOR ARGENTINE REPUBLIC BY ORLANDO BROTHERS, LEGHORN, ITALY.

Sister ships, with slight differences in armament, are "Christobal Colon" (sunk) and "Pedro d'Aragon" (Spain); "Giuseppe Garibaldi" and "Varese" (Italy); "Garibaldi" and "San Martin" (Argentine Republic.)

Displacement, 6,882 tons. **Speed,** 20 knots. **Bunker Capacity,** 1,100 tons. **Armor:** Belt, 6 inches; deck, 1½ inches. **Armament,** two 10-inch B. L. rifles, fourteen 6-inch rapid-fire guns, four 3-inch, ten 2¼-inch, and eight 1½-inch rapid-firers, two landing guns. **Torpedo Tubes,** 4 submerged. **Complement,** 450. **Completed,** 1898.

The age of Niagara Falls, as indicated by the erosion at the mouth of the gorge, formed the subject of a paper by Prof. G. Wright, read at the recent Boston meeting of the American Association. The late Dr. James Hall early noted the significant fact that "the outlet of the chasm below Niagara Falls is scarcely wider than elsewhere along its course." This is important evidence of the late date of its origin, and it has been used in support of the short estimates which have been made concerning the length of time separating us from the Glacial period. A close examination made by Prof. Wright last summer greatly strengthens the force of the argument, since he found that the disintegrating forces tending to enlarge the outlet and give it a V-shape are more rapid than has been supposed. As a result of his investigations, he concludes that a conservative estimate of the rate of disintegration for the 70 feet of Niagara shales supporting the Niagara limestone would be 1 inch a year, with a probable rate of 2 inches a year. But at the lowest estimate no more

than 12,000 years would be required for the enlargement of the upper part of the mouth of the gorge 1,000 feet on each side, which is very largely in excess of the actual amount of enlargement. According to Prof. Wright, the age of the gorge cannot be much more than 10,000 years, and is probably considerably less.

THE STEAM YACHT AS A NAVAL AUXILIARY.*

By W. P. STEPHENS, Associate.

THE conditions under which the members of this society meet for this the sixth time are very different from those of former years, and of such a nature as to test, in a measure, the value of the work thus far accomplished. Heretofore both papers and discussions have been largely of a theoretic and speculative character; far removed from war in the past, and with no immediate indications of it in the near future, the great problem of naval warfare has of necessity been treated almost from an academic standpoint. In describing and discussing the vessels, armor, and guns of the new navy, the most that has been possible was to conjecture what they might do if put to trial. To-day we are in a position to discuss what they have done, to test by the practical work of the last six months the theoretic work of this society for the previous five years. It is interesting to note that the weakness of our navy, the imperfect preparation for such an emergency as is likely at any time to confront the most peaceful nation, the imperative necessity for work in various lines of defense; that have only recently been realized by the nation at large; have been among the most prominent topics of discussion at all the meetings of the society; coupled with many suggestions and urgent demands for action.

The subject of this paper is but one of many that have already come before the society in their theoretic aspects, and now, when tried by practice, it presents results which seem to be both definite and conclusive; and from which some useful lessons may be drawn.

The work of reconstruction which has been under way in the United States navy for the past fifteen years has been limited almost entirely to the strictly fighting arm of the service—the battleships, cruisers, and torpedo craft. Indispensable as they are, these of themselves do not constitute a perfect navy; in fact, they are of comparatively little use without a large attendant fleet of auxiliary craft; transports, colliers, water boats, repair ships, supply ships, hospital ships, and small craft for various uses.

The condition of the navy at the outbreak of hostilities between the United States and Spain may be briefly summed up as strong in its personnel; comparatively strong in fighting vessels, guns, and armor; and absolutely unprovided with auxiliaries of all kinds. Of all the urgent work demanded both ashore and afloat, nothing was more immediate and pressing than the creation of an efficient fleet of auxiliaries.

Among the numerous classes coming under this general head is one that is hardly accorded the distinction of a specific title in naval programmes, but which, in the present case, was needed for three important uses, as follows:

First.—For sea service as tenders to the blockading fleet, and general service in the shoal harbors and rivers of the West Indies, where the war vessels were barred by their draught.

Second.—For picket duty offshore, constituting the "Second Line of Defense."

Third.—For harbor patrol duty in connection with the guarding of mine fields and the enforcing of the war regulations governing ports and harbors.

The preparation of this particular branch was but one detail of the important task intrusted to the "Naval Auxiliary Board," specially created at a time when the possibility of war had almost crystallized into a certainty. This board proceeded at once to examine a very large number of vessels, ranging from the large passenger steamers of the American line down to the smaller sizes of tugboats and yachts; and, in accordance with its reports, vessels were purchased from the special appropriation made by Congress for the purpose of defense.

For the work above outlined two classes of vessels were selected, the ocean-going tug and the steam yacht, the latter to the number of 27. The selection was made from many localities, several of the yachts coming from the Great Lakes. The vessels were mainly purchased direct from the owners, the price being fixed by the board. As soon as the transfer of title was completed the yacht was delivered at the nearest navy yard, where the work was pushed as rapidly as possible. As a matter of course, the majority of the yachts hailed from New York, and the work on them was consequently executed at the Brooklyn navy yard.

The capabilities of these vessels for successful conversion to war purposes were, as we shall see later, not of the best; but the facilities for carrying out the work were in the main satisfactory, the skilled labor and the necessary material being readily obtained. The only difficulty encountered in this part of the work was in the detail of armament, there being a lack of some of the sizes of guns best fitted for these small vessels.

To the yachtsman, at least, the sight of the well-known vessels as they left the navy yard was a surprise and also a shock; under a dull monochrome of "war paint" (lead color) covering everything from waterline to truck, the distinctive color scheme of the yacht was effaced entirely; there was no longer a trace of the green "boot top," the jet black topsides relieved by gilded cove and trail boards and figurehead, with the sheer cut out cleanly by a strip of polished teak. The rich brown of the deck houses, the bright yellow of the spars, and the white sails set off by the parti-colored burgee at each truck, had all disappeared. The bowsprit was sawed off just outside the gammon iron and brought to a blunt point, the foretopmast shared a similar fate, projecting but a few feet above the cap, and the mainmast had disappeared entirely. A pair of 3 or 6-pounders grinned menacingly from the forecastle, a couple more from the quarterdeck, and bridge and deck house each showed an automatic gun. The rowing boats were retained, but the steam and naphtha launches were left ashore.

As each vessel was completed she was dispatched to her station, many going direct to Key West and from there to the Cuban coast; others were stationed along the coast of the Eastern and Atlantic States to give warning of the approach of the expected Spanish fleet, while the smaller ones were assigned to duty in the harbors of New York, Boston, and other important seaports. At the outset the sea picket division was regarded as the most important of the three, but as matters turned out it had nothing to do, and after Cervera's fleet took refuge in Santiago Harbor, it was withdrawn and the vessels dispatched to more southern stations. The work of the harbor patrol fleet was also very light, mere policing of the mine fields against the intrusion of garbage scows and coasting schooners.

While specific information as to the individual performances of the main division of the yacht fleet in actual service is not yet at hand, enough is known to establish the fact that the fleet, as a whole, acquitted itself creditably and fully justified its creation. While some of the converted yachts proved failures and entirely unfit for sea work, and others were only partly satisfactory, many of them have done excellent work under trying conditions. The part played by the "Gloucester" and "Vixen" at Santiago was such as to bring them into special prominence, but the "Mayflower," "Yankton," "Scorpion," and others have done regular and consistent service, though under conditions which have attracted less attention to them.

The work of laying up this fleet really began before the actual cessation of hostilities, the smaller yachts of the harbor patrol being withdrawn and placed out of commission at the Brooklyn navy yard and other points. One yacht, the "Free Lance," presented to the government by her owner, F. Augustus Schermerhorn, Esq., without conditions, was returned to him as soon as the need for her services in the New York Harbor patrol fleet was over. Another similar gift, the "Buccaneer," presented by W. R. Hearst, Esq., was also returned later on, being in Cuban waters when hostilities ceased. At the time of writing, most of the yachts have returned from the West Indies, the majority of these to go out of commission. The "Gloucester," "Scorpion," "Vixen," "Mayflower," and others of the larger and abler are still in service. One yacht, a new craft uncompleted at the time of purchase and placed in commission only after the need for her was past, has been reserved for the special use of the President, a service heretofore performed by such government tugs, lighthouse tenders, or other small craft as were temporarily available. She has been named "Sylph," and her original arrangements, as a private yacht, have been modified to suit this new use. No decision has yet been made as to the disposal of the yachts remaining, twenty-five in all, but it is probable that most of them will be offered for sale, ultimately returning to the pleasure fleet.

In summing up what has been at best an experiment arising from an emergency which should never have occurred, it may be said in regard to the home divisions of the converted fleet, the sea pickets and harbor patrol, that the course of the war has been such that no serious or prolonged service was required of either, and the merits of the fleet were not put to a practical test. Had, however, the anticipated attack upon the North Atlantic coast proved a reality, it is safe to say that the yachts would have met all expectations. In the case of the third division of the fleet, the vessels were put to the severe test of prolonged service at sea, under conditions for which they were never intended, and they were also engaged in attacks upon land fortifications and in some cases in engagements on the sea. The result of this test has been, on the whole, quite as satisfactory as could have been expected.

The possibilities of the yacht fleet at the present time for conversion to war uses were, even from a theoretic standpoint, far from promising. Many of the vessels were ill fitted in model for real service at sea; there was a lack of displacement for the added weights of armament and ammunition, of berthing space for crew, of bunker space, and suitable locations for magazines. The nominal speed, in many cases low in itself, was not realized even in smooth water, and in a sea there was a serious loss of the average working speed. There was no protection, no distilling apparatus; the capacity of the water tanks was generally inadequate, and the decks were not designed to withstand the shock of the guns. The draught, as a rule, was greater than was necessary or desirable. The nature and extent of these defects were fully realized at the outset, but under the circumstances there was no other course but to take the yachts as they were and to make the best of them. All things considered, they have done their work quite as well as was to be expected; they have served a certain necessary purpose, and they were capable of doing even more, had it been required of them.

It is to be hoped that some of those who have had actual experience on board of the yacht fleet will tell us in the discussion the results of their personal observations, which cannot fail to be interesting and of permanent value; but, short of this, enough is now known to permit of a discussion of the future position of the yacht fleet as a naval auxiliary.

It is impossible within the limits of the present paper to discuss the auxiliary fleet as a whole; but to those of us who have followed the discussions of this Society year by year the experiment must be an interesting one. The lessons to be derived from it are, first, the necessity for timely preparation in the speedy building up of an adequate navy; and, second, that, to be done properly, this work must proceed for a term of years according to a comprehensive and systematic programme, completed in advance and carried out as nearly as possible without change through successive administrations. A reference to the transactions of the Society will show that these two points have been emphasized in the course of almost every discussion of the naval papers.

The detail of the auxiliary fleet now under consideration, the yacht division, has, as I shall endeavor to show, a special lesson of its own: that the naval programme may be advantageously extended to include a type of small auxiliary indicated by the yacht, but not now in existence in this country.

The present use of the yacht fleet being confessedly but an emergency measure, the question naturally suggests itself as to whether such a course would have been necessary had our navy been theoretically complete in all of its branches; notably, had the gunboat and torpedo arms, instead of being exceedingly weak, been developed to the same extent as in other navies.

This question may at once be answered in the affirmative, for the reason that none of the vessels of the gunboat or torpedo boat types are adapted for the special service demanded of the converted yachts. The high speed which is the leading motive of torpedo boat design is not only needless for the work now under discussion, but entails the loss of many essential qualities. Incidentally, it may be observed, there has been, with the exception of one yacht, "Mayflower," no attempt to convert the yachts into torpedo boats; and had there been enough torpedo boats at hand for this service, the only available crews, largely made up from the naval militia, would have been unfit to handle them.

Assuming, then, that, however perfect the torpedo arm may be, there is still a distinct field of usefulness for something of the yacht type, we come to the question discussed at the first meeting of this Society in 1893, of the policy of reliance upon the pleasure fleet as a regular means of defense in the future.

The suggestion has been made in this connection that some scheme of co-operation between the government and individual yacht owners might be put into practice whereby, in return for certain privileges or compensations on the part of the former, the latter might be induced to plan any new yachts with a direct view to their conversion to war uses. The objections both to this method of procedure and to the general policy of reliance on the yacht fleet are very strong. On the part of the government, the only effective inducement to be offered to the owner must be in some form of subsidy, a sort of special legislation which is practically impossible. On the part of the owner, his personal requirements, to say nothing of the wishes of his captain, his wife, and his friends, are directly opposed to those of the war vessel. There is, it is true, a common ground whereon the owner and the government might come together to mutual advantage in demanding the essentials of good design, a seagoing model, fair working speed, ample bunker space, etc., but in too many cases these are but secondary to the demand for spacious saloons and lavish display of furnishings. To the owner who is willingly paying a very large sum for mere luxury and elegant appointments, the government can offer but slender inducements to make his vessel a ship first and a palace afterward; or, when completed, to loan her for a time as a practice ship, as has been suggested as one feature of the scheme.

Unless very much more can be done in this direction than now seems possible, the experience of the present year is such as to indicate that the purchase and conversion of yachts is in every way undesirable as a permanent feature of naval policy. The defects of the existing fleet have been already indicated, many of them are mere matters of faulty design due to the haphazard methods that have thus far largely prevailed in this country, the owner leaving everything to his captain, who in turn deals directly with a builder. This class of defects will largely disappear as soon as the American yacht owner awakens to the appreciation of the importance of the trained specialist, the yacht designer, in the field of steam yachting, as he has long since done in that of the sailing yacht. At the same time the good qualities of a perfect steam yacht are not of necessity such as to make her an ideal picket or patrol boat; and of the fleet available at any future time for conversion, many will be found to possess positive bad qualities, as in the present case.

As a matter of permanent policy, however, the question of the efficiency of the converted yacht is but secondary to that of the cost, always a controlling one in a naval programme. The circumstances attending the purchase of yachts for this purpose are necessarily such as to keep the price at a fair figure, and this price represents a large amount of furniture and decoration which is worse than useless, as its very removal entails some expense. Apart from this waste, the yacht needs to be strengthened for gun mounts, etc., and remodeled in all the internal details. When the emergency is passed and she is no longer needed, her value as a yacht will have seriously depreciated, and the work of reconversion must be far more costly than that of the first change, as its details are reversed. Where the furnishings were hastily stripped at a mere cost of labor, new ones must be purchased and put in place; where spars were simply sawed off, new ones must be made and shipped; and in place of a plain coat of lead color over everything, regardless of appearance, the entire structure must be scraped and redecorated by skilled artisans. When the present experiment has reached its final stage in the sale of many of the yachts, and the result is reduced to plain dollars and cents, there will probably be little room for doubt as to the unprofitable nature of the work.

While the actual co-operation of the government and the yacht owner is hardly practicable, each may study with profit the lesson now before them.

It is obviously to the interest of the government to encourage the building and use of yachts. Apart from the indirect advantages of a national pleasure fleet, there is always the possibility of an occasion like the present, when the larger vessels must be depended on as a dernier ressort. While nothing can be done in the way of direct financial aid, it is a wise and sound policy to encourage yachting by the removal of all unnecessary and oppressive regulations.

On the part of the owner, it must be apparent to him now, if never before, that his interest lies directly in putting his money into a vessel that as far as possible possesses the prime essentials for conversion to war use. It may happen, as in this case, that the opportunity to sell her at a fair figure is coincident with a temporary inability to use her on account of war. How far he can go in the compromise between his individual requirements and adaptability for conversion is a question to be settled with his designer; but he will hardly fail to realize that it is too important a matter to be disregarded entirely, as it has been in the past.

A careful study of the history of the yachts in the present war will show two important points: first, the theoretic value of vessels of the yacht type; and, second, the limited extent to which the yacht fleet as a whole has realized in practice its theoretic efficiency.

* Paper read at the Annual Meeting of the Society of Naval Architects and Marine Engineers, New York city. November, 1898.

The work demanded and in part accomplished by the yachts is not properly within the field of either the gunboat, the destroyer, or the torpedo boat. The former is too large; the torpedo vessels, of all classes, are designed mainly for a speed which not only is absolutely unnecessary for this special work, but is obtained through the sacrifice of essentials.

The gunboat class in the new navy had its origin in the "Petrel," built in 1887, of 850 tons displacement, 11 feet 7 inches mean draught, and 11·5 knots speed; a vessel now notable from her part in the battle of Manila Bay. The development of this class since then has been entirely upward, to vessels of 1,700 tons displacement; and no attempt has been made to carry it downward from the "Petrel." Useful as they are, the gunboats now in service and the new ones under construction are unfitted by their size for the work assigned to the yachts.

So far as the torpedo boat is concerned, the present war has been devoid of results; not only is the question of the true relative value of the torpedo fleet as much an open one as it was a year ago, but false lights have been thrown on it (through the poor performance of the Spanish destroyers, and also the good work of the converted yacht "Gloucester") which are calculated to mislead, at least the popular mind. It cannot be too strongly stated that the idea, quite widely prevalent, that one converted yacht is the equal of two of the modern torpedo boat destroyers, is entirely erroneous. The destroyer and torpedo boat are to-day quite as formidable as they were a year ago, quite as essential, and with a wide field of usefulness on which nothing of the yacht type can intrude. At the same time, their limitations are numerous and well defined; they are necessarily most expensive and delicate machines, lacking protection, armament, bunker space, and crew accommodation; they demand special picked crews, whose endurance is severely tested in comparatively short trips at sea; and they are at all times liable to speedy deterioration. The value of each individual boat depends mainly on the spirit and training of her crew, and her excess of speed above others

The intended uses of this class call for three sizes: for sea work, as dispatch boats and tenders, and for picket duty, vessels of not over 800 tons displacement, about the size of the "Gloucester" and "Scorpion," the draught not exceeding 11 feet in a single screw boat; twin screw boats of this size with draught reduced to 9 feet would be very serviceable, as proved in the present case, for harbor and river work. The next size to be of about 400 tons displacement, about the size of the "Hist," "Eagle," and "Hornet," twin screw vessels of 7 to 8 feet draught, intended for sea service as pickets. The third size, for harbor patrol service, to be of about 200 tons and 6 feet draught, designed for smooth water, carrying a light armament and limited supply of coal. A speed of 15 knots would suffice for this service, but they should be capable of towing a vessel out of possible danger.

The requirements here set forth are in a general way but the theoretic qualities of the converted yacht, not fully realized now in any one vessel, but easily obtained in a special design. To the specialist in torpedo boat design or to the yacht designer, the problem would be a simple one. On the one hand, the demand for very high speed, approaching 30 knots, with its eggshell construction and numerous limitations, is entirely eliminated; and on the other, the numerous and conflicting requirements of the private owner as to amount and disposition of space are replaced by fewer and simpler ones. A vessel of this type could be built for far less than either the torpedo boat or the converted yacht; she would fulfill her own special mission, covering a very wide range of usefulness, better than either; she could be handled to advantage by the average crew, not necessarily experienced men; she could, when not needed, be laid up for an indefinite time, ready for service at a few days' notice; and when thus laid up she would not be subject to the double deterioration of the torpedo boat: physical in the actual disintegration of her light frames and plating, and technical in the outbuilding by vessels of newer design and higher speed. As practice vessels for the naval militia for short intervals in the summer, a purpose for

Two 5-inch rapid-firers in forward waist; two 6-pounder rapid-firers on forecastle deck; eight 6-pounder rapid-firers on bridge deck; two 6-pounder rapid-firers on main deck, aft; two 6-millimeter Colt guns on taffrail; two 6-millimeter Colt guns on bridge.

Magazines for supplying ammunition to the above battery were built in the forward and after holds, with ammunition cranes fitted to hatches directly over for delivering ammunition on deck.

Two 18-inch broadside torpedo tubes were fitted in dining room, on main deck, each supplied with three torpedoes.

Steel plating ⅜ inch thick and 8 feet wide was worked on the outside of the vessel for the length of the engine and boiler space.

Owner's staterooms (three) were fitted up for the use of the captain. Library was refitted for officers' mess room. Drawing room, dining room (yacht), officers' quarters, and crew's quarters (yacht) were cleaned out and fitted for crew's berthing. Officers were berthed in guests' staterooms, lower deck, aft. Staterooms on same deck forward used for ship's stores.

"Corsair."—Renamed "Gloucester." Arrived at Quintard Iron Works, New York, April 22. A battery of ten guns was mounted, as follows:

Four 6-pounder rapid-fire guns, main deck, forward; three 3-pounder rapid-fire guns, main deck, aft; one 3-pounder rapid-fire gun, forecastle deck; two 6-millimeter Colt guns, midship deck house, forward end.

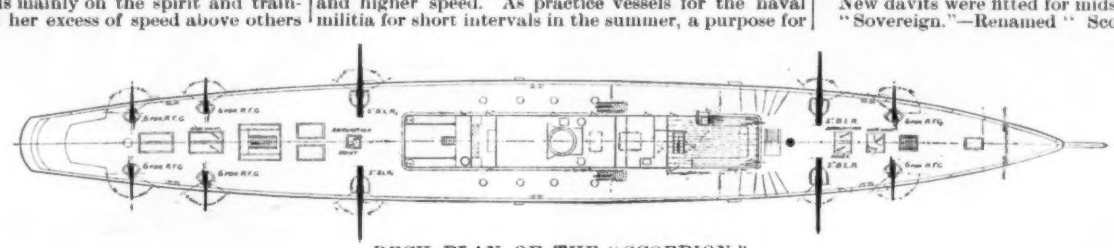
Magazines for supplying the above battery were built in the forward and after holds. Ammunition cranes were fitted to hatches directly over the magazines.

The forward deck house was entirely removed, also foremast and fittings, and bowsprit and fittings. The mainmast was replaced by a light signal mast.

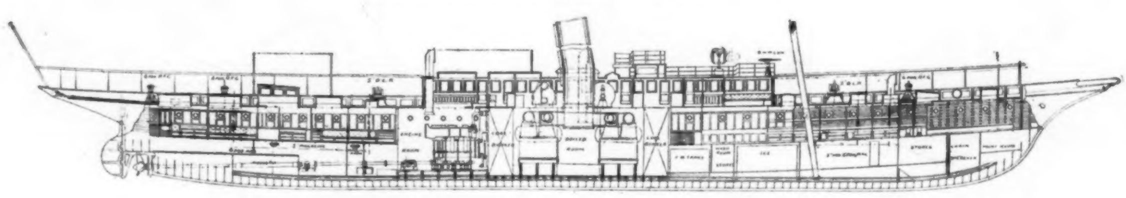
Yacht officers' quarters on forward berth deck, also former owner's dining room, were stripped and fitted up for crew's berthing.

New davits were fitted for midship boat.

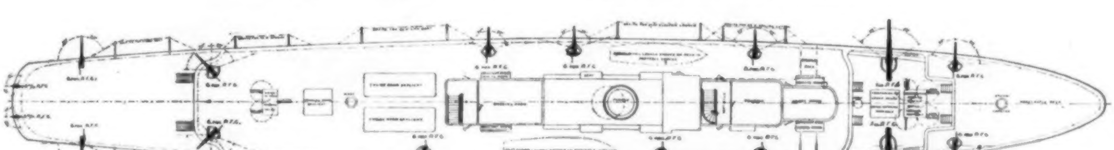
"Sovereign."—Renamed "Scorpion." Arrived at



DECK PLAN OF THE "SCORPION."



LONGITUDINAL SECTION THROUGH THE "SCORPION."



DECK PLAN OF THE "MAYFLOWER."

of her class. Had there been at hand this spring an ample fleet of torpedo boats, they would have been of but little use, for the reasons that the trained crews to man them were lacking and the men who were available, largely from the naval militia, were incapable of handling such delicate tools.

The work of the yachts, their success and failures taken together, with the work of other small craft such as tugs, lighthouse tenders, etc., impressed into the same service, seems to indicate the desirability of the creation of a new type of small auxiliary not at present recognized on the navy list. The controlling feature of design, the speed, may at the outset be placed at a moderate figure for this era of increasing speeds, not over 18 knots. This, however, is not to be measured by the conventional yacht standard by which an 18-knot steam yacht takes the wash of a good 12-knot tug, but means a reasonable approach to the designed speed under ordinary service conditions at sea, and the ability to keep with the fleet even in bad weather. The model should possess seagoing qualities of the highest class; the draught should be limited to 11 or even 10 feet as a maximum; the construction should be durable, with ample scantling both to carry the armament and to insure a long life with ordinary care in laying up; the engines should be strong and reliable, the bunker space as large as possible, and, as deck and side protection will probably be impracticable, especial attention should be given to the waterline protection of machinery and magazines through their location and the disposition of the bunkers. The accommodation should include healthy and comfortable quarters for a proportionately large complement of officers and crew for an indefinite time, and the armament should be comparatively powerful, with the guns more advantageously located than is possible on a yacht. Special provision should be made for magazines, ammunition hoists, distilling apparatus, and minor auxiliaries. There should be no sails, and no spars except the single military mast, and in all cases torpedo tubes should be excluded. Profiting by one serious defect of the yachts, special attention should be directed to the disposition of space in holds and bunkers so that it may be utilized to advantage without a material change of trim.

which it has been suggested yachts might be borrowed, these vessels would be superior to either the yacht or the torpedo boat. They would carry a larger number of men than the torpedo boat, their armament of 4-inch, 5-inch, and 6-pounder rapid-fire guns would be better suited for practice than the two extremes of the torpedo and the 1-pounder; and while the larger sizes would be capable of practice cruises at sea, the smaller with their limited draught would be well adapted for such work as the exploration and study of local waters, as now carried on by the naval militia.

With suitable designs once completed for each size of vessel in the class, there would be no necessity to modify them with each new improvement that gives speed; and the attention of the designer might be concentrated upon the perfecting of details and such a reduction of engines and other parts to established standards as would minimize the cost of construction, and also make it possible to add to the class very quickly in the case of an emergency.

An examination of the smaller types of gunboats in use by other nations would disclose many interesting points; but it is not necessary to go outside the immediate experiences of the past six months for several important conclusions. The conditions of coast defense, as thus indicated, involve certain work which is not within the legitimate field of the existing gunboat class or of the high speed torpedo boat; and which can only be done imperfectly and at great expense by means of the conversion of the steam yacht. A special class of vessel fully fitted for this work can be constructed at a comparatively moderate cost; and, once provided in sufficient numbers, can be laid up for an indefinite time in a condition for almost immediate use.

In venturing to present these conclusions to those who have enjoyed more extended opportunities for observing the present fleet in actual service, I earnestly hope that they may deem them worthy of their attention and criticism.

SUMMARY OF WORK DONE ON CERTAIN STEAM YACHTS, 1898.

"Mayflower."—Name retained. Arrived at Brooklyn navy yard March 17. A battery of eighteen guns was mounted, as follows:

Brooklyn navy yard April 2. A battery of twelve guns was mounted as follows:

Two 5-inch rapid-firers, main deck, forward; two 5-inch rapid-firers, main deck, aft; two 6-pounder rapid-firers, main deck, forward; four 6-pounder rapid-firers, main deck, aft; two 6-millimeter Colt guns on forward side of bridge.

Magazines for supplying ammunition to the above battery were built in the forward and aft holds, with ammunition cranes to hatches.

Steel plating ⅜ inch thick and 8 feet wide was worked on the outside of vessel for the length of engine and boiler space.

Owner's dining room and forward deck house, yacht officers' quarters and yacht crew's quarters were cleaned out and refitted for crew's berthing.

Mainmast and fittings were entirely removed, bowsprit was cut down.

In each case the vessel was drydocked, cleaned, and painted throughout. All plumbing, drainage system, and auxiliaries were overhauled and put in order. The entire exterior of the vessel, including spars and metal deck fittings, was painted lead color.

Paint for Toilet Rooms, etc.—The ammonia and hydrogen sulphide gases constantly forming in these places do not admit of the use of white lead oil paint, as the same is blackened and comes off in scales. Zinc white paint in pale tints is serviceable for these localities. If the price paid allows it, zinc white dammar varnish paint or enamel paint should be employed. For painting the walls lime colors are most suited, if possible in a neutral gray, so as not to afford too much prominence to the obscene inscriptions which are frequently met with in such places, says a Munich publication (Die Mappe). If a light wall coating is desired by the owner, make a base about 2 meters in height, rough cast if possible; paint the upper wall quite light, equal with the ceiling, feebly yellowish broken. In many towns in Germany there is a police ordinance requiring a cement base 2 meters high in toilets. This is quite commendable, but the condition that it be painted with oil paint shows little understanding of the subject.

ROMAN CONSTRUCTION.*

By G. W. PERCY.

MANY books have been written and innumerable plates have been published describing and illustrating the wonderful architectural and engineering works of the ancient Romans.

The history of Roman art is well known. Their architectural forms are recognized by every intelligent observer, and the minute details of their style and orders have been familiar to architectural students for the last three centuries.

There is hardly a known fragment of Roman architecture in existence that has not been carefully measured, drawn, and published to the world during the present century.

And yet, with all this widely published knowledge of Roman art and architectural forms, there has been very little attention given in modern times to Roman methods of construction, and very few, even among architects and engineers, are aware of the fact that the ancient Romans, especially of the best days of the Roman empire, devised and perfected a method of construction perfectly adapted to their gigantic works and possible of execution with unskilled labor and with the cheapest and most common materials.

Nearly all writers who have attempted to describe Roman buildings and the materials with which they were built have classed them as of cut stone or of brick faced with marble.

Others who have investigated a little beneath the surface have described some Roman walls as a combination of brick and rubble stone work, with occasional bond courses extending entirely through the walls, consisting of large flat tiles.

Vitruvius, the earliest architectural writer whose works have come down to us, declares, in the introduction to his ten books, that he has developed all the principles of the art of architecture. Yet, while he describes very minutely all classes of building material and their proper use, he gives no hint of what the ruins show to be the true Roman construction of walls and arches, which method became general about his time. Whatever Pliny and other ancient writers have recorded of Roman construction they appear to have copied from Vitruvius.

During a visit to Rome in 1882 the writer was much interested in examining the stupendous ruins of buildings, aqueducts, etc., and noticed what to him was a strange discovery—that the walls and arches of such buildings as the Baths of Diocletian and Caracalla, the Basilica of Constantine and many other ruins were not of bricks, as he had been led to suppose, but of great masses of concrete, faced with bricks. In many places where the brick facing had been stripped off the concrete mass presented a rough face with numerous indentations, as if bricks had been laid diagonally with the corners penetrating the concrete. This was a new revelation to him, but he had neither the means nor time to investigate further than what was on the surface and exposed to view. The discovery, however, added new zest and desire to read whatever he found about Roman construction. When in 1885 a book was published by J. H. Middleton, an English architect, entitled, "Ancient Rome in 1885," giving the result of extensive investigations, and revealing the fact that all so-called brick walls in Rome of ancient construction were of concrete, faced on both sides with triangular bricks. Middleton declares that there are no walls of ancient Rome built throughout of brick, and that walls only seven inches thick are faced with very small triangular bricks and filled with concrete. (See Fig. 1, *a*.)

This made clear the cause of the indentations which had so puzzled the writer, and showed a logical intent on the part of the builders.

In a more recent work, "The Art of Building Among the Romans," written by Auguste Choisy, a French architect, a translation of which by Arthur J. Dillon was published in The Brickbuilder during the years 1892-95, makes clear to English readers for the first time the system practiced by the ancient Romans. To this work the writer is indebted for the graphic illustrations of this paper, and to some extent the descriptions.

The etchings by Piranasi show how some of the ruins appeared one hundred and fifty years ago, while the photographs show the appearance of other ruins at the present time.

It will be seen by examining these etchings and photographs * that in many places what appear on the surface to be brick arches over openings and relieving arches through the body of brick walls have fallen out or have been destroyed, and the remaining mass shows that the arches, like the plain facings, were but skin deep.

A close examination of the interior surfaces of domes and the soffits of large arches often reveals a framework of thin brick arches forming a skeleton of bricks embedded in the mass of concrete or rubble work.

Auguste Choisy made a thorough examination of these and other peculiarities and arrived at the following conclusion: that Roman masonry generally consisted of an agglomeration of small stones and mortar, with facings of cut stones or triangular bricks, except for foundations and other works below the level of the ground where the earth, and sometimes timbers, served to confine the mixture. This concrete or fine rubble work is of two kinds—that which was placed in trenches or behind solid stone revetments was of rammed masonry, formed by spreading a layer of mortar 4 or 5 inches thick, and then spreading over it a layer of equal or greater thickness of small broken stone and ramming the stone down into the bed of mortar, thus forcing the mortar into all the interstices and bringing some of it to the surface. Then a thin layer of very fine fragments and dust resulting from the facing of the cut stone was spread, which prevented the mortar from adhering to the feet or tools of the workmen, and the whole was again rammed solid, when the operation was repeated with a fresh layer of mortar, rock, and dust, thus making a very compact mass in well defined layers 8 or 9 inches in thickness. (Fig. 2.)

This method seems to have been employed in all cases where heavy cut stone facings or earth pressure gave sufficient resistance to the outward thrust caused by the ramming.

The other method of building with conglomerate masonry, and where ramming is not employed, is by far the most common, and is always found where brick or small stones are used for facings. These facings were doubtless laid one or two courses at a time and for the same purpose as the larger stones, to confine the fresh rubble and to form straight and true faces to the walls,

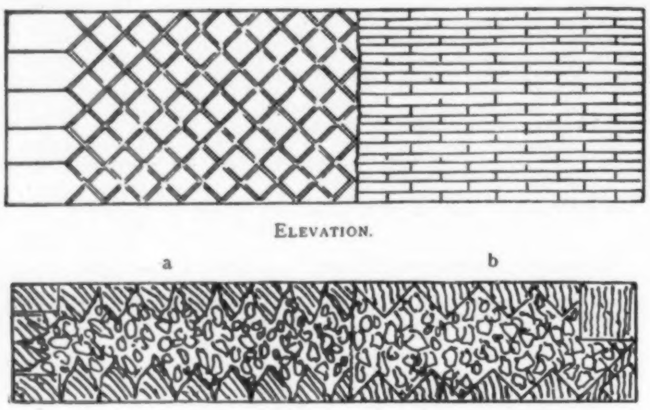


FIG. 1.
PLAN OF WALL.

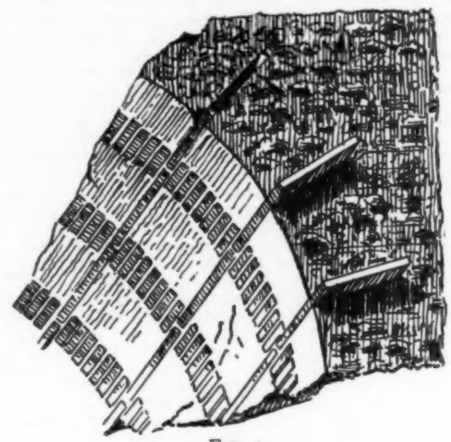


FIG. 4.

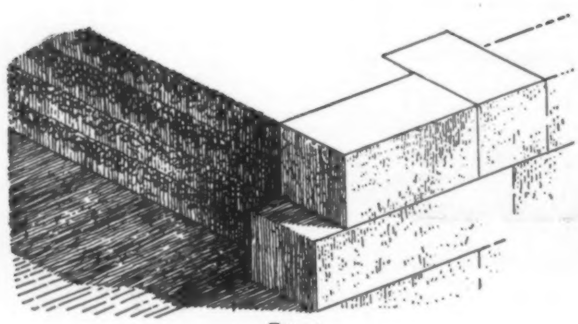


FIG. 2.

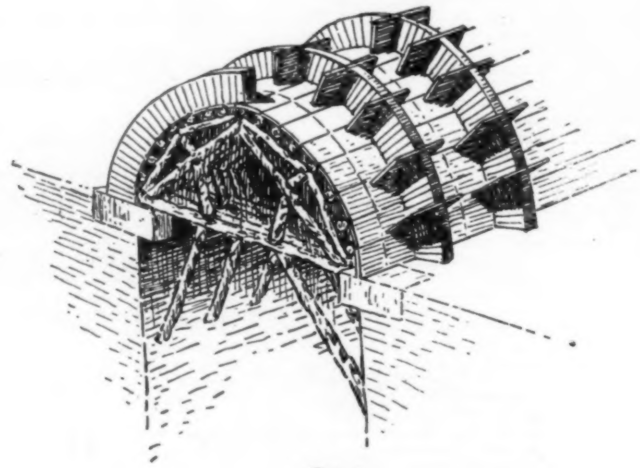


FIG. 5.

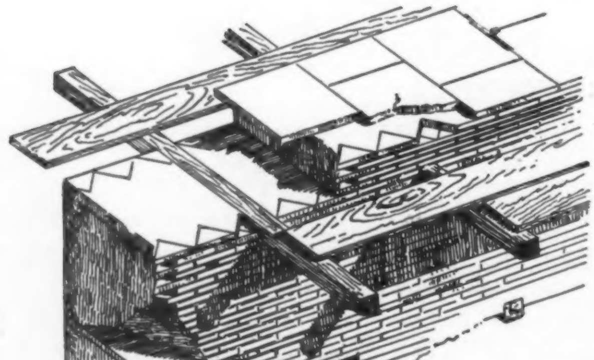


FIG. 3.

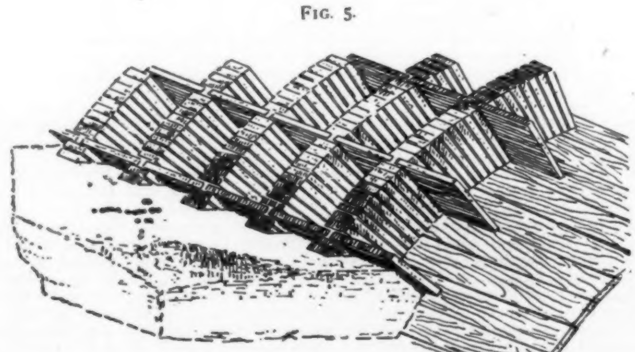


FIG. 6.

ROMAN CONSTRUCTION.

* Read before the Association of Engineering Societies and published in the Journal of the Society.

* Etchings and photographs omitted in publication.

which were afterward veneered with marble or covered with stucco.

Some writers have assumed that the interior filling was mixed as concrete is now, and poured while in a semi-liquid condition between the facings, but Choisy demonstrates quite clearly that such could not be the method employed, but that layers of lime mortar, as before only from one to one and a half inches in thickness, were spread between the facings, and then the broken fragments were placed by hand and pressed down into the mortar. This is shown by the fact that the stones are always placed on their natural bed, and where pieces of pottery are used they are always placed with their faces following the horizontal plane; and again where fragments two or three inches thick are used, as sometimes occurs, it is frequently found that the layer of mortar spread over the top does not go down between these large fragments to meet the lower bed of mortar, thus leaving gaps in the vertical joints which would not occur in a mixed semi-liquid concrete, and which are seldom, if ever, found in the rammed work.

The triangular bricks used for facing such walls and confining the rubble were from one foot to twenty inches long and from one to one and one-half inches in thickness, and laid generally with very thick joints, often one inch in thickness, of lime mortar, generally with pozzuolana used in place of sand.

Often, in the earlier works, the faces of the walls were of small stones about six inches square on the face and from ten to twelve inches long, and laid with diagonal joints forming what Vitruvius calls "reticulatum opus." (Fig. 1, *b*.)

In all these cases we see that the principal object of the brick and small stone facings was to confine the rubble work and protect it during the process of setting and hardening, while at the same time it was thoroughly incorporated in the mass of the wall.

In this manner all expense and wastefulness of temporary curbing was avoided, and substantial walls were erected, largely with unskilled labor and with the commonest materials.

In building walls of this character it is evident that some method of bonding the two opposite faces at intervals should be employed, and this (Fig. 3) the Romans effected in two different ways. Often both methods were employed in the same wall.

In the first method sticks of roughly hewn wood were placed, extending entirely through the wall. Vitruvius refers to this method of bonding, and says in Chapter 5, Book 1: "The walls ought to be tied from front to rear with many pieces of charred olive wood, by which means the two faces thus connected will endure for ages. The advantage of the use of olive is that it is affected neither by weather, by rot nor by age. Buried in the earth or immersed in water, it lasts unimpaired, and for this reason not only walls of cities, but foundations and such walls as are of extraordinary thickness, tied together therewith, are exceedingly lasting."

It is quite probable that these bonding sticks were allowed to project on both sides of the walls to support scaffolding for the workmen and materials, and, when the walls were finished, they were cut off flush with the face.

The wood has rotted out from all these Roman walls, but the imprint in the masonry gives proof beyond question of their former existence.

The second method of bonding, which has proved more durable than even charred olive wood, is also shown in Fig. 3. It consists of flat tiles of burnt clay, or large bricks, about two feet square, and from one and one-half to two inches thick. These are often used in single layers from four to eight feet apart, and sometimes with two or three courses together. This method of bonding is a strongly marked peculiarity of Roman walls wherever found in Europe.

But it is in the construction of vaults and arches that we find the ingenious method of the Romans carried to its greatest perfection, and the greatest saving of skilled labor and expensive materials.

While arches of cut stone with radiating joints were used by the Romans in their bridges, triumphal arches, city gates, and some other monumental structures, rubble vaults were far more common and were built on a most stupendous scale.

These vaults, formed of small materials, were of infinite variety, and are found covering rectangular and polygonal spaces, rotundas, and exedras; for being, as it were, moulded, they could be adapted to the most varying forms, and could be made to meet all of the numerous requirements of planning.

The Romans may or may not have been the inventors of rubble vaults, that is to say, of vaults of small stones bound together with mortar; but it is certain that before them no one thought of constructing vaults of large span of such materials. With them it seems to have been developed during the latter days of the republic and the early days of the empire, or about the beginning of the Christian era.

The system developed rapidly, and the Pantheon is preserved to us, a masterpiece of the art and one of its earliest examples.

If one inspects an edifice vaulted with rubble, as for example the great baths of Caracalla, he will perceive on the face an arch of brick with radiating joints, and behind these face arches a rough masonry similar to the interior of the walls we have described; but if one examines these masses of masonry more closely, he discovers courses of an entirely separate construction embedded in them, real ribs, sometimes entire networks of bricks forming skeletons in the body of the rubble.

This skeleton must not be considered as a series of relieving arches built at the same time as the rubble and intended to strengthen it. These arches of bricks in the Roman vaults were built first, with radiating joints and bonded to each other and to the face arches at intervals with large tiles, thus forming a complete framework which could be built on a light and inexpensive centering, and which in turn supported the body of the arch as it was carried up with horizontal courses exactly as described for the walls.

Fig. 4 shows the appearance of such a vault with the facing bricks removed.

It is evident that the construction of wooden centering, of sufficient strength to carry such massive arches in a perfectly rigid state while being built, would be a work of great expense and delay, requiring vast quantities of timber, considerable skilled labor, and a great deal of time, all of which the Roman builders sought to avoid using unnecessarily.

Some centering indeed was necessary to support the light ribs of bricks on which to form the rubble. Such centering was constructed in as light and crude a manner as possible, generally of round or rough hewn logs, supported on corbels of brick or stone projecting from the wall, roughly formed to the curve of the arch with bricks and earth, and, where necessary, further supported by vertical props. (Fig. 5.)

This rough centering was often paved with a layer of large, thin, burnt tiles, laid with open joints which would receive the rubble masonry and adhere firmly to it, thus forming the permanent soffit of the arch when the centering was removed. At other times it was covered roughly with boards which have left their imprint in the masonry of the arches.

The ribs or armatures of the arch were then turned rapidly and roughly, as is shown by their irregularity in many of the ruins. They were usually constructed with bricks about six by twenty-four inches, slightly wedged and laid in strong lime mortar. At intervals of two feet or more large tiles or bricks about twenty-four by twenty-four inches were built in, forming wings, as shown in Fig. 5, or bonding the ribs together, as shown in Fig. 6. At other times the ribs are built in pairs, with a space of eight or ten feet between them, as is shown in Fig. 7.

In still other cases, where very large arches were to be turned, as in the Basilica of Constantine, where they are about seventy feet span, these ribs were made double in height, as is shown in Figs. 8 and 9.

These light ribs of brick, once completed and bonded together over the rude centering, were of sufficient strength and rigidity to support the rubble work as it progressed, and were swallowed up by it, becoming thoroughly incorporated as a permanent part of the construction.

It is evident also that the work need suffer no delay while the centering and ribs were being constructed; for, as shown in Fig. 10, the overhang of the walls was slight for about one-third of the height of the arch, and up to that height would cause little or no pressure on the ribs or centering, but it was necessary that the ribs should be completed before the work was carried higher.

(To be continued.)

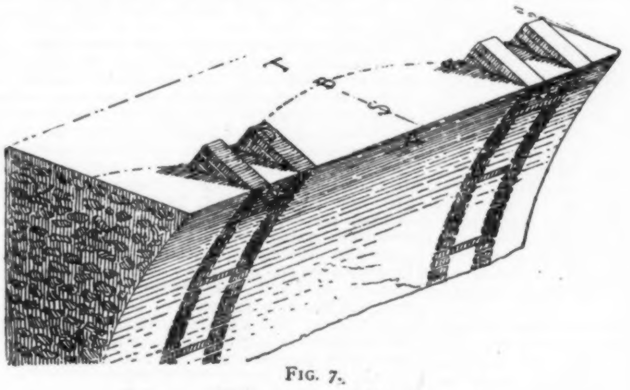


FIG. 7.

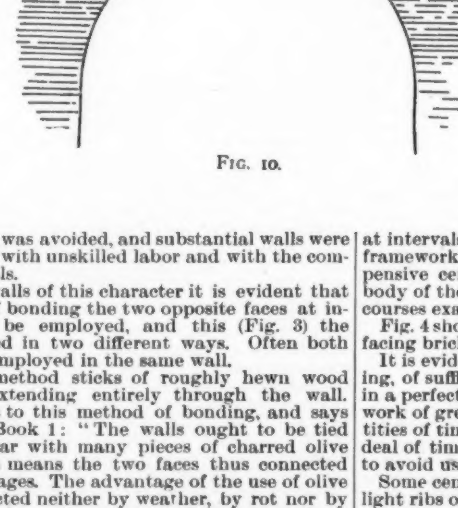


FIG. 10.

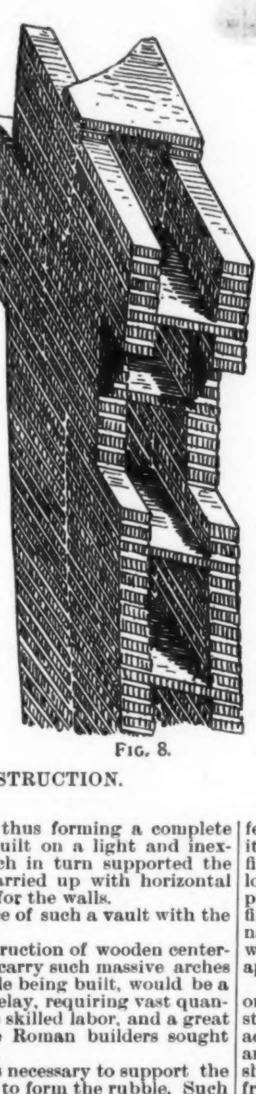


FIG. 8.

FIG. 9.

ROMAN CONSTRUCTION.

USE OF ALUMINUM IN WARFARE BY THE ARMIES AND NAVIES OF THE WORLD.

ALMOST any one who has followed the development of aluminum, and has kept up with the progress which the metal has been making in its general introduction into the arts and manufactures, will realize the great advantage which this metal has when properly used, for different purposes in the various armies and navies of the world while in active operation. The principal feature which is to be gained by the use of aluminum in warfare is its lightness combined with its strength, when taken in comparison with other metals.

Taking up the question first of how aluminum could be used to advantage in the navy, the first uses to be considered are those things about a ship which could be made of aluminum, and then of the construction of the ship itself. In modern warships the great feature to be gained is lightness, not only of the ship itself, but of everything which goes to make up its fittings and furnishings. Aluminum has been used so long for cooking utensils that its advantage for this purpose is no longer questioned, and they are rapidly finding their way into use not only in the United States navy, but in the principal foreign navies of the world, which seem to have recognized its importance and appreciate it more than our government.

Some of our new torpedo boats, however, have not only cooking utensils of aluminum; but also the washstands, washbasins, and the fittings of a similar character are of aluminum. Other articles which are made and used to advantage in aluminum are cleats, blocks, sheaves, compass boxes, lamps, lamp frames, truck frames, and a variety of other articles which have heretofore been manufactured of brass or composition. The ammunition which the ships, that are at all heavily armed, are obliged to carry is something enormous, and in the rapid-fire guns, which use brass shells, the brass forms a considerable item of the weight.

Aluminum has been used to a limited extent to replace these brass shells. The difficulty, however, which has been found in its use in this direction is that the metal anneals at a fairly low temperature, and after a shell has been fired several times, the heat which is generated tends to anneal the metal and render it too soft for reloading and for withdrawing from the gun. This is especially so where melinite or smokeless powder is used. This powder generates a much greater heat than the ordinary powder.

Some alloys of aluminum, however, anneal at a much higher temperature than others, and a series of experiments are now in progress to determine upon an alloy which can be made of a sufficient temper to allow the metal to be properly and successfully drawn into the shape of a shell, and when the shell is completed to be of such a character that it can be used a reasonable number of times without the heat which it has to

undergo in the firing of the shell rendering it too soft to be reloaded. The English government has had better success in that direction than has been had in this country, and the shells for some of their guns are now made out of aluminum and are reported to be working satisfactorily.

The weight which is to be saved, however, in the fittings and furnishings of a ship is small in comparison to what can be saved by using aluminum in the construction of the ship itself. Taking up the construction first of small craft, such as steam launches which have to be lifted on and off the ship, there is no reason why the entire boat cannot be built of aluminum, with the exception of the working portions of the engine, which, of course, have to be of steel. Such things, however, as bed plates and frames and the majority of the piping can be made to advantage of aluminum, as well as the sheathing and all work pertaining to the hull. This, as previously stated, applies to steam launches and torpedo boats.

The advantage to be gained in a torpedo boat, however, is more apparent than would first appear, for the reason that a boat of a given size constructed of aluminum, in comparison with one of the same size constructed of steel, would weigh about one-half as much, after due allowance had been made for the increased thickness of the aluminum over what would be required in steel. A boat so constructed of aluminum would require less power to drive it through the water, owing to the fact that the submerged portion is less than that of a boat built of steel.

Another point which is equally as advantageous is the fact that a boat so constructed of aluminum has its center of gravity materially lowered, and consequently makes a more stable craft than if its center of gravity is high, as in the case of a steel boat. These points, however, not only increase the efficiency of the boat, but if, as the tendency seems to be, they are designed for a certain draught and size in steel, the use of aluminum allows them to carry in ammunition and coal an amount in excess of that ordinarily carried which would be equal to the difference in weight between an aluminum and steel boat. This, as has been previously stated, would amount to nearly one-half of the weight of the boat.

Taking up the next question of boats of a larger class, such as torpedo boat destroyers, where they also want great speed, lightness, and, probably most important of all, a low center of gravity, aluminum can be used to advantage, if not in the construction of the entire boat itself, at least in the construction of that portion of the hull which is above water. By building a boat in this manner it is a sort of compromise between an all steel and all aluminum boat, and is suggested by naval authorities principally for the reason of the saving in expense. There is this to be argued against building the hulls of torpedo boats and torpedo boat destroyers of aluminum, and such craft as are not lifted out of the water, and that is that the corrosion of aluminum and the marine growth which would form on the bottom of such a boat is as bad as in the case of steel; but, although this is so, it is no worse than in the case of steel, and any boat which can be built of steel to advantage can be built of aluminum so far as corrosion enters into the question.

It might be interesting to note here that it was only about thirteen years ago that the famous shipbuilder John Roach wanted the government to build the hulls of some of their boats of steel. Being a man of some influence, the Secretary of the Navy appointed a board of naval authorities, well versed in the construction of ships, to investigate the question as to the advisability of building hulls of ships of steel. After a great deal of deliberation the board reported adversely, and said that the corrosion would be so great, together with the formation of marine growth, that it would not be possible to construct a boat on these lines.

Through Mr. Roach's influence, however, another board was appointed, and after an investigation extending over many months, they decided that steel could be used in the construction of the hull of a ship under certain conditions and restrictions, and that they thought it would pay the government to build such a boat as an experiment, if for nothing more. At the request of the Secretary of the Navy, Congress, therefore, appropriated money for the construction of a boat of steel and one was ordered built. It is the impression of the author of this article that the "Dolphin" was the boat constructed, but on this point he cannot speak positively.

John Roach was awarded the contract for the ship, and the different large manufacturers of steel in the country were asked if they could make a steel under the requirements set forth by the board making the favorable report. All of them replied, with one exception, that they did not know whether they could or not, but that they would try. One mill in Pittsburg, however, that had been encouraging the construction of steel ships, said that they could make the steel without question in accordance with the specifications.

After the contracts were awarded and the actual manufacture was started, the steel was finally furnished by the different mills of a satisfactory grade, different mills furnishing different portions, with the exception of the one mill making the positive statement that they could manufacture satisfactory steel, and they were not able to make any steel that would pass the government inspection. They, however, learned something regarding the rolling of steel, and the other mills of the country have perfected the process, so that to-day the statement can be made that the only iron entering the construction of a ship is in the form of castings, and even a great majority of the castings are now made from cast steel.

This is simply mentioned in connection with this article on aluminum to show the progress which has been made in the construction of ships in comparatively recent years, and the development of aluminum to-day and the knowledge that it can be used in the construction of marine craft is better understood and further advanced than was the use of steel when the second board was appointed by the Secretary of the Navy to investigate the practicability of using it, and owing to the many advantages to be gained by the use of aluminum its future development in this direction is bound to be more marked, and equally as extensive, as the introduction of steel has been.

Probably the best construction of a torpedo destroyer would be to have that portion of the hull which is submerged constructed of some of the bronzes, with all that portion above water, together with all frames inside, constructed of aluminum. This recommendation is made for the reason that a boat built on these lines has all the advantages of a strong hull and one as free from corrosion and the collection of marine growth as it is possible to build, with the additional advantage that by the use of aluminum as above described the center of gravity is materially lowered, which is of vast importance, especially in a heavy sea and for high rates of speed. This also gives a boat with a lighter draught, or of the same draught with a greater coal carrying and ammunition capacity than could be got if the boat was constructed entirely of either steel or bronze.

There is one point in the use of aluminum, however, around salt water which the author cannot lay too much stress upon or recommend carried out too carefully, and that is that aluminum must be kept clean or kept painted. Also it must be kept free from galvanic action caused by contact with other metals. This can readily be done where aluminum comes in contact with other metals by inserting between the metals some form of non-conducting material, such as canton flannel soaked in white lead or some similar arrangement of non-conducting medium.

Taking up next the question of ships still larger, such as cruisers and battleships, many of the frames could be made to advantage of aluminum, together with ammunition hoists and possibly watertight compartment doors. These items are quite essential and important, as their weight amounts to a considerable tonnage, and the facility in handling them, owing to their lightness, is a material item in an emergency. The other advantages which have been mentioned in connection with similar craft also apply to battleships and cruisers. The German government, as well as some of the other governments, have constructed torpedo boats of this class entirely out of aluminum which have proved satisfactory. This was some years ago, however, and even that construction can be improved upon, owing to the advance which has been made in the different alloys of aluminum and the increased strength and facility in working which has also been developed.

Considering next the use of aluminum in the army, its advantage here is probably more apparent to the individual man than in the navy, for the reason that this advantage is to be appreciated by each man personally. The German government has gone so far as to equip four entire army corps, so that all of the metal, with the exception of the rifle, is of aluminum. This includes everything that a soldier has to carry, cartridge boxes, cartridge cases, canteens, cups, sword handles, bayonet scabbards and everything down to the buttons on their clothes and the pegs in their shoes. Even all of the devices on their helmets and the stirrups and metal work of the saddle are made of aluminum.

The next step, and what they are working for now, is to get a serviceable and practical horseshoe. This has recently been put on the market and has been pronounced a success. The advantages to be derived by the use of such a shoe are many, not only to the horse itself in having a less weight to carry, but in the carrying and putting on of shoes in the field. Some armies require each cavalryman to carry in his saddle bags an extra set of shoes, and the increased weight of steel shoes in comparison with aluminum is a material item, amounting to nearly two pounds. A steel shoe cannot be properly fitted and put on in the field without the use of a fire, whereas any farrier with a hammer can put on an aluminum shoe cold much more rapidly than a steel shoe can be put on.

By the use of aluminum shells for cartridges a soldier can carry about one-third more ammunition with the same weight. Aluminum is used in the manufacture of powder and is coming generally into use for this purpose. Powder used to be made by pressing it between plates in large presses, and many explosions have occurred by getting the powder too dry and the plates sparking when sliding upon each other, or by handling the plates carelessly. Aluminum, however, does not spark and can be used in powder presses readily and with safety, which process of manufacture is now adopted by nearly all the large powder works.

Another great and important use of aluminum in the army and navy is in its introduction into telephone and telegraph wire. This can be carried and laid economically owing to its lightness in comparison with copper, with a saving in weight of about one-half. This is, after making all due allowance for an increased section of wire, owing to the fact that its electrical conductivity is not quite as great as that of copper.—The Aluminum World.

THE EXTRACTION OF NICKEL FROM ITS ORES BY THE MOND PROCESS.*

THE Mond process marked an entirely new departure in metallurgical practice and in the principles which had hitherto guided it. It depended on the remarkable property possessed by nickel of forming a volatile compound with carbon-monoxide, from which metallic nickel might be released if the gaseous compound was heated to 180° C.

The methods hitherto employed for extracting the metal from its ores involved concentrating the nickel either as a sulphide (matte or regulus) or as arsenide (speise), followed by either dry or wet treatment; and the metal had to be refined, mainly with a view to separate it from associated carbon.

In 1889 Dr. Ludwig Mond, in collaboration with Dr. Carl Langer, had been engaged upon a method for eliminating the carbon-monoxide from gases containing hydrogen. They had been guided by the observation that finely divided nickel removed carbon from carbon-monoxide at a temperature of 350° C., converting it into carbon-dioxide, whereas the dissociation of carbon-monoxide by heat alone, according to Victor Meyer and Carl Langer, remained incomplete at the high temperature of 1690° C. The experiments were carried out in conjunction with Dr. Friedrich Quincke; finely divided nickel, formed by reducing nickel oxide at 350° C. by hydrogen, being treated with pure carbon-monoxide in a glass tube at varying temperatures. The gas escaping from the apparatus was ignited, and while the tube containing the nickel was cooling, the flame became luminous, and increased in luminosity as the temperature sank below 100° C. Metallic spots were deposited on a cold plate of porcelain held in this luminous flame, and on heating the tube through which the gas was escaping a metallic mirror was obtained, while the luminosity of the flame disappeared. These metallic deposits were found to be pure nickel. Nickel carbonyl was then isolated in a liquid state, and it was possible to produce it with facility in any desired quantity. It could be readily distilled without decomposition, but on being heated to 150° C., the vapor was completely dissociated, pure carbon-monoxide being obtained and the nickel being deposited in a dense metallic film upon the sides of the vessel.

No other metals which were submitted to investigation showed indications of combining directly with carbon-monoxide except iron. The discovery that in a mixture of metals only nickel and iron would form volatile compounds with carbon-monoxide, and that they could, therefore, be separated from the other metals, induced Dr. Mond to arrange experiments with ores containing nickel, cobalt, iron, and copper, such as "kupfer-nickel" and "pyrrhotine." The experiments afforded such promising results that apparatus of considerable size, though still within the limits of the resources of a laboratory, was set up, and in it several pounds of ore could be treated with carbon-monoxide. The principal nickel ores which were metallurgically treated contained the nickel in combination with arsenic and sulphur, besides other metals and gangue. These ores had first to be submitted to calcination, in order that the nickel might be present in the form of oxide, and to drive off, as far as practicable, the arsenic, sulphur, and other volatile bodies. The resulting oxide of nickel was treated with reducing gases, such as water gas or producer gas, in order to convert the oxide of nickel into finely divided metallic nickel, and the material containing it was cooled to about 50° C., and was treated with carbon-monoxide.

In 1892 an experimental plant on a large scale had been erected at Smethwick, near Birmingham. The process began with "Bessemerized" matte; it ended with the market product, commercial nickel. The Bessemerized matte proceeded to the first operation of dead roasting, after which the matte contained 35 per cent. of nickel, 42 per cent. of copper, and about 2 per cent. of iron. It then passed to the second operation for the extraction of part of the copper (about two-fifths) by sulphuric acid, the copper being sold as crystallized sulphate of copper. The residue from this process contained about 51 per cent. of nickel, and it passed to the third operation for reducing the nickel. Incidentally, the remaining copper was reduced to the metallic state, care being taken to avoid reducing the iron. This was effected in a tower provided with shelves, over which mechanical rabbles passed, the reducing agent being the hydrogen contained in water gas. The temperature did not exceed 300° C., and should be kept lower when much iron was present. From this tower the ore was conveyed continuously to the fourth operation of volatilization, in which part of the nickel was taken off by carbon-monoxide and formed the compound nickel carbonyl. The formation of this volatile compound was effected in a tower similar to the reducing tower, but the temperature was much lower, and did not exceed 100° C. From the volatilizer the ore was returned to the reducer, and it continued to circulate between the reducing and the volatilizing stages for a period which varied between seven days and fifteen days, until about 60 per cent. of the amount of nickel had been removed as nickel carbonyl. The residue from this operation, amounting to about one-third of the original calcined matte, and not differing much from it in composition, was returned to the first operation and naturally followed the same course as before. The nickel carbonyl produced in the fourth operation passed to a decomposer, which consisted either of a tower or a horizontal retort heated to a temperature of 180° C., so as to decompose the nickel carbonyl and release the nickel in the metallic form, either on thin sheets of iron or, preferably, on granules of ordinary commercial nickel. Carbon-monoxide was in turn also released, and was returned to the volatilizer for taking up a fresh charge of nickel. When the operation was in progress, the gaseous carbon-monoxide and the partially reduced oxide of nickel and copper continuously revolved in two separate circuits, which joined and crossed each other in the volatilizer. The commercial product contained 99·8 per cent. of nickel.

The author proceeded to a description of the working as he saw it in full operation in Smethwick a few months ago. The plant had been working for some time, and about 80 tons of nickel had already been extracted from different kinds of matte. The results were quite satisfactory, and pointed to the conclusion that the process was well able to compete with any other process in use for the production of metallic nickel.

The process would always occupy a prominent position in chemical history, and there appeared to be no reason why it should not play an important part in metallurgical practice. Its application in Canada to the great nickeliferous district of Sudbury would probably contribute to the development of the resources of the great Dominion.

* Abstract of paper read at the Institution of Civil Engineers, on November 8, by Prof. W. C. Roberts-Austen, C.B., F.R.S., and published in Nature.

Attention is attracted to the shell concrete roadways of Macon, Ga., which resist wear and tear uncommonly well. The material used is a shell limestone, of which there is a bed about thirty miles from Macon, and which was discovered during the construction of the Georgia Southern and Florida Railroad. Part of the roadbed of that railway was made of it, and it hardened into such a durable form that it was also laid down at the goods station, where it resisted the wear of the heavy traffic unusually well. After it had been in service for four or five years, the city authorities paved a street having one of the heaviest grades in Macon with it, and this first street gave such satisfaction that several more have since been paved in the same manner. The stone is crushed and laid on the bottom excavated to receive it, and the layer is about 7 inches deep at first and is consolidated by a 15 ton steam roller to a thickness of 6 inches.

ENGINEERING NOTES.

An easy rule for the size of gas piping is to allow two circular eighths of an inch of sectional area per light for pipes under twenty yards long, and three circular eighths of an inch per light for pipes fifty yards long.

The contract for the pipe line which is to furnish water to the Coolgardie mining district, in Western Australia, has been finally awarded to two Australian bidders—Hoskins Brothers, of Sydney, and Mephan Ferguson, of Melbourne. The work will require 246 miles of steel riveted pipe, 31 inches in diameter, and 82 miles of welded pipe from 26 to 29 inches diameter. The specifications require acid open hearth steel to be used for the pipe. The work is to be pushed as fast as possible. Although the contractors are Australians, they have come to the United States for their material, and it is understood that Pittsburg mills will furnish the steel plates required. The construction of this long pipe line involves some engineering questions the solution of which will be watched with interest.

Apropos of the abandonment by the Delaware & Hudson Canal Company of a part of its water route, The Engineering News says: "It is plainly evident that a few years more will see the entire disappearance of the old-time canal barge as a vehicle for freight transportation. The 60,000-pound freight car is a competitor which it cannot meet. The only ones of the old time canals on which even a semblance of their old time traffic is to be found are such canals as the Erie, where the taxpayers foot the bills for maintaining and operating the canal. Even here, however, the question of who is to carry on the traffic in the near future is a serious one. The profits to the canal boatmen for several years have been so meager that hardly any new boats have been built for some time; the old boats are fast becoming rotten and useless, and with the present uncertainty as to the future policy of the State respecting the canal, no new investments in boats to ply upon it are likely to be made."

The following, dated Moscow, has been received by the Department of State from Consul Smith: As is generally known, a commission has been sent along the route of the Siberian Railway for the purpose of deciding the question of increasing the traffic capabilities of the road. A meeting was held at Tomsk and the journal Siberian Life says that it has been decided to increase the gage. The traffic capacity is to be increased to enable seven sets of trains to be run every twenty-four hours instead of three, as at the present time. It has also been noted that an increase of rolling stock, cars, platforms, etc., will be necessary. More powerful engines than the so-called six pair or six-axled engines in use at present will be obtained. The estimated cost of all the above projected improvements is about 16,000,000 rubles ($8,000,000). A general reduction in railway passenger fares is to be shortly made in Russia, which will involve changing the tickets now issued. This will cause a very large outlay; to the St. Petersburg-Warsaw Railway alone, this change of tickets will mean an expense of over $17,000.

About the only good reason that exists to-day for building a cable tramway in preference to one operated electrically is, says Cassier's Magazine, heavy grades—extraordinarily heavy grades, in fact—and many cable roads now operating are practically relics of obsolete engineering practice. Indeed, in the case of one of the two large cable roads in the city of New York the work of transformation into an electric road with underground conductor is now actively going on, the experience with the open conduit electric traction system having been wholly satisfactory even there, where a few years ago exceptional difficulties for this type of tramway were expected to result from uncleaned streets. The other tramway company will probably commence similar constructional work in the near future. In the light of such experience, cable tramway building under ordinary conditions seems a bit antiquated, and even the almost all-pervading overhead electric trolley is in prospective danger of being ousted, at least from big towns, where the traffic returns are heavy enough to warrant the demand upon the companies to adopt the conduit construction. In small places the insistence upon this form would almost certainly bring financial disaster to the companies, owing to the necessarily high cost of rebuilding the lines, and it is, therefore, most unlikely for the authorities to exercise what right may be theirs. It is a pleasing reflection, however, that underground electric trolley systems so called, or, more properly, open conduit systems, have shown themselves beyond all doubt to be practically successful, and in large cities profitable investments of the first order.

Track tanks for supplying locomotives with water while running have been in high favor, chiefly because of the saving in time which their use made possible. Opinion is rapidly changing, however, and their abandonment by the Maine Central is a sign of this. The American Engineer says they do not pay under the conditions of operation which now generally obtain in that country. The tanks are expensive to build and to maintain, the water must be prevented from freezing in cold weather, and it is difficult at all times to keep it free from cinders and dirt. The tender attachments also cost a great deal, and altogether the elevated tanks appear to be preferred for all cases, except those requiring long runs without intermediate stops. The water column system on most railroads needs revision, however, and it is likely to be made a subject of general improvement. This has already been inaugurated on several Western roads by the use of tanks, elevated enough to give a good head of water, and the employment of large pipes and stand pipes or water columns. Eight-inch pipes or smaller should be discarded as soon as possible and replaced with larger ones, say 12 inches in diameter, through which a 4,000-gallon tender tank may be filled in less than one minute. When the pipes are small delays occur, and more coal must be burned to keep trains on time. This is a strong argument for the large pipes, and even if they cost more than small ones, the money will be returned many fold. Some of the best roads have not yet taken this subject up in earnest, but they probably will do so when they come to appreciate the advantages. Station delays are very expensive, and they grow more so with the increasing number of fast schedules.

ELECTRICAL NOTES.

Another Swiss electric railway working on the three-phase system is announced in the Electricien between Stansstad and Engelberg. The length of the line is about 11 miles, and part of it has a gradient of 25 per cent., on which the rack-and-pinion system will be used. The power will be derived from Obermatt, where our contemporary states that a fall of 1,250 feet will be utilized.

The Crehore and Squier synchronograph has recently been tested on the submarine cable of the commercial Cable Company running between New York city and Canso, Newfoundland. A simple sinusoidal wave of impressed electromotive force is expected to give higher speed on cables with the same dielectric strain as it does on overhead lines with the same impressed electromotive force.—Electrical World.

The Chicago, St. Paul, Minneapolis and Omaha Railway Company have had fitted up an electric pump for the protection from fire of the railroad freight house at Itasca, Wis. In the station is a system of electric signals and switches by which one man can turn on the power over a mile away, start the electric pump, and get water for a fire in a few seconds. The pump is of the double-acting triplex form, with a capacity of 750 gallons per minute.

A bridge of 900 feet span, at Budapest, is being erected entirely by means of electrical machinery. The iron girders used as piles to keep the water back from the excavations for the shore pillars were driven in by an electric ram. The ram was a hammer rising 34 feet, with a velocity of 12 feet per second. The spoil out of the holes was raised by an electric windlass. The water was removed by seven centrifugal pumps working day and night. The 5 inch diameter pumps were driven by 10 h. p. motors, the 8 inch by 16 h. p., and one 9 inch by a 20 h. p. motor.

Some time ago Mr. Lyons, of Glasgow, said he had discovered a method of refrigeration by means of electricity without any machine being a necessary part of the plant. Mr. Fay, an American gentleman, does not go so far as this, yet he obtains refrigeration by electrical means. Writing in the interests of the electrical station engineers, he explains the simple methods by which private users can, by means of a motor, produce their own refrigeration. He describes the motors and plant necessary for the purpose in a series of articles in The Electrical Engineer, New York.

The twenty-first quarterly fire report of the Electrical Bureau of the National Board of Fire Underwriters, just issued, by William H. Merrill, Jr., shows thirty-six fires from unusual electrical causes, says The Iron Age. In the report Mr. Merrill says: Frequent breakdowns and short circuits from defective knife switches indicate that greater care should be taken in the selection of switches to insure their having sufficient mechanical strength, as well as a proper separation of polarities and suitable break distances between terminals. The custom of merchants in the smaller cities, where a commercial circuit of series of arc lights is operated of leaving current on wires after closing premises until dynamo at station is shut down is strongly to be condemned. The principal losses due to fires from arc lamps have occurred under such conditions. Central station fires in this report, showing losses aggregating $87,000, are believed to have been of electrical origin, although indisputable proof could be had in but one of the three cases. In the other two, fires started at some distance from boiler rooms in the vicinity of switchboards, indicating that electrical defects were responsible.

According to L'Elettricita, electricity as a motive power is rapidly being adopted for various purposes in Italy. At Naples the construction of an electric street railway is progressing rapidly, which, when completed, will connect the Museum and the Toretto. This, it is claimed, is the first step toward the transformation of the whole Neapolitan street railway system—a matter which will shortly be considered by the Municipal Council. The municipal authorities of Savona have petitioned the Postmaster-General to connect their town with Genoa. A company has been formed in Turin for the purpose of building an electric trolley line from Varallo to Aragna. Another company has been formed in Bologna for the purpose of manufacturing and distributing current for lighting and motor purposes. The Mediterranean Railway Company is going to try electricity on its lines. The first trials will be made on the line from Milan to Gallarato and the three branch lines to Arona, Varese, and Laveno. In all thirty-four applications have been made for water power for the generation of electrical current; twenty-nine of these have been granted, as being able to supply that demand without damaging other interests. From the above it will be seen that electrical undertakings are flourishing in sunny Italy.

The utilization of fish refuse for the extract of oil has never been successful in France, but in England not only has oil been successfully recovered from such remains, but a heavy oil, rich in insulating qualities, has been extracted from fish guano, says The Western Electrician. This oil costs next to nothing, and has a considerable commercial value. It is available for all electrical purposes, and may be converted by pressure into slabs for dynamos, transformers, switchboards. It has been made into pulleys, wagon wheels, railroad ties, and coach bodies. Objects of art have been manufactured from it which neither temperature nor humidity affected. Fibrous manufactures impregnated with this heavy fish oil and treated similarly to the same kind of insulating materials are said to be superior to vulcanized fiber, and may be substituted for hard rubber. The oil costs about 600 francs per ton and sells at 3,500 francs. For several months, says Andréoli, in L'Electricien, we have ozonized fish oils, which were much improved in color, fluidity, and odor. Ozone may be made to change these oils to a condition bordering on semi-solidification. Much, it would seem, is possible in that direction. There are several methods of manufacturing substitutes for caoutchouc and ebonite from siccative oils, and fish oils, after having been thickened by ozone, in the hands of specialists, may enjoy an important role in the insulating industries where durability, impermeability, and resistance to high electrical tensions are prerequisites.

SELECTED FORMULÆ.

Metallizing Wood.—In the French journal Les Mondes a process for metallizing wood, invented by one Rubennick, is described as follows: The wood is immersed for three or four days, according to its permeability, in a solution of caustic lime, at a temperature of from 75 to 90° C. From there it is placed at once in a bath of calcium hydrosulphate, to which, after 24 or 36 hours, a concentrated solution of sulphur and caustic potash is added. This bath lasts about 48 hours, at 35 to 50°. Finally, the wood is treated for 30 to 50 hours to a bath of acetate of lead, also at 35 to 50°. It will be seen that the process requires considerable time, but the result is surprising. After having been dried at a moderate temperature, the wood thus prepared shows, when polished, a brilliant metallic luster. This luster can be heightened still more by rubbing the surface with a piece of lead, tin, or zinc, and then polishing it with a glass or porcelain burnisher. The wood surface then assumes the appearance of a genuine metallic mirror, and is very solid and strong.

White Lilac Extract.—The newer handkerchief extracts have a synthetic perfume base as the predominant odor. White lilac is simulated nearly by both terpineol and aubepine. In the following formula terpineol is recommended:

Terpineol	75 grammes.
Alcohol	2½ fl. ounces.

Dissolve and add:

Oil ylang-ylang	2 minims.
Essence ambergris	40 "
Essence musk	40 "
Extract jasmine	7 fl. ounces.
Extract jonquil	7 "
Extract orange flower	7 "
Extract rose	7 "
Extract tuberose	7 "

Mix.

White Violet Extract.—Try the following:

Ionone (10 per cent. sol.)	1 fl. drachm.
Musc Baur	10 grammes.
Oil of orris	10 minims.
Extract of violet	18 fl. ounces.
Extract of rose	2 "
Oil of sweet orange	5 minims.
Oil of lignaloe	5 "
Amyl acetate	30 "
Heliotropin	30 grammes.
Terpineol	5 minims.
Spirit of patchouli (10 per cent.)	20 "
Glycerin	30 "

Mix. —American Druggist.

Electroplating of Aluminum.—Lanseigne and Leblanc, in the Journal de Pharmacie et de Chimie, give the following formulæ for fluids for covering aluminum with silver, gold, copper, and nickel. The article must be well cleaned with a dilute solution of an alkali (soda or potash) or with a weak solution of hydrochloric acid, and rinsed with water. The anodes must consist of the metal with which the plating is being done. The baths are:

SILVER.

Silver nitrate	2 parts.
Potassium cyanide	4 "
Sodium phosphate	4 "
Water, distilled	100 "

GOLD.

Gold chloride	2 parts.
Potassium cyanide	2 "
Sodium phosphate	2 "
Water, distilled	100 "

COPPER.

Copper cyanide	6 parts.
Potassium cyanide	9 "
Sodium phosphate	9 "
Distilled water	100 "

NICKEL.

Nickel chloride	7 parts.
Sodium phosphate	7 "
Distilled water	100 "

Warm the baths from 60 to 70° C. and maintain them at this temperature throughout.

Freezing Mixtures.—The lowering of temperature produced by the solution of salts has its commonest illustration in the use of a mixture of ice and common salt in the freezing of ice cream. Under favorable conditions, a temperature of 0° F. may be obtained, this mixture it is said being the one used in originally arriving at the "zero" point.

Lowering of temperature by solution of a salt is promoted in many cases to a marked degree by the presence of a diluted acid. The following is an example:

	Parts.
Commercial sulphuric acid	40
Water	21
Powdered sodium sulphate	12

Mix the acid and water, allow the mixture to cool to the temperature of the atmosphere, then add the powdered sodium sulphate and place in the center of the mixture the receptacle containing the substance to be cooled.

The freezing mixture should be made in a vessel of low conductivity, as earthenware, while the container of the mixture to be chilled should be as good a conductor of heat as possible.

From among various other formulas which have been proposed for freezing mixtures, we quote the following from Watts' Dictionary of Chemistry:

		Parts.
I.	Crystallized sodium sulphate	8
	Hydrochloric acid	5
II.	Water	1
	Ammonium nitrate	1
III.	Water	1
	Ammonium nitrate	1
	Sodium carbonate	1
IV.	Snow or crushed ice	1
	Crystallized calcium chloride	2

This latter is said to be especially effective.—Druggists' Circular.

THE OPENING OF THE FIRST SECTION OF THE JUNGFRAU RAILWAY.

By WILHELM BRAND.

A GREAT undertaking is usually opposed by great opposition. That is human nature. A railway on the summit of the Jungfrau! What a bold idea! How people did protest against it at the beginning! And, indeed, certain reasons for this opposition are not far to seek. They were brought forth in the Swiss Bundesrath, and were fully considered before concessions were granted to construct the road.

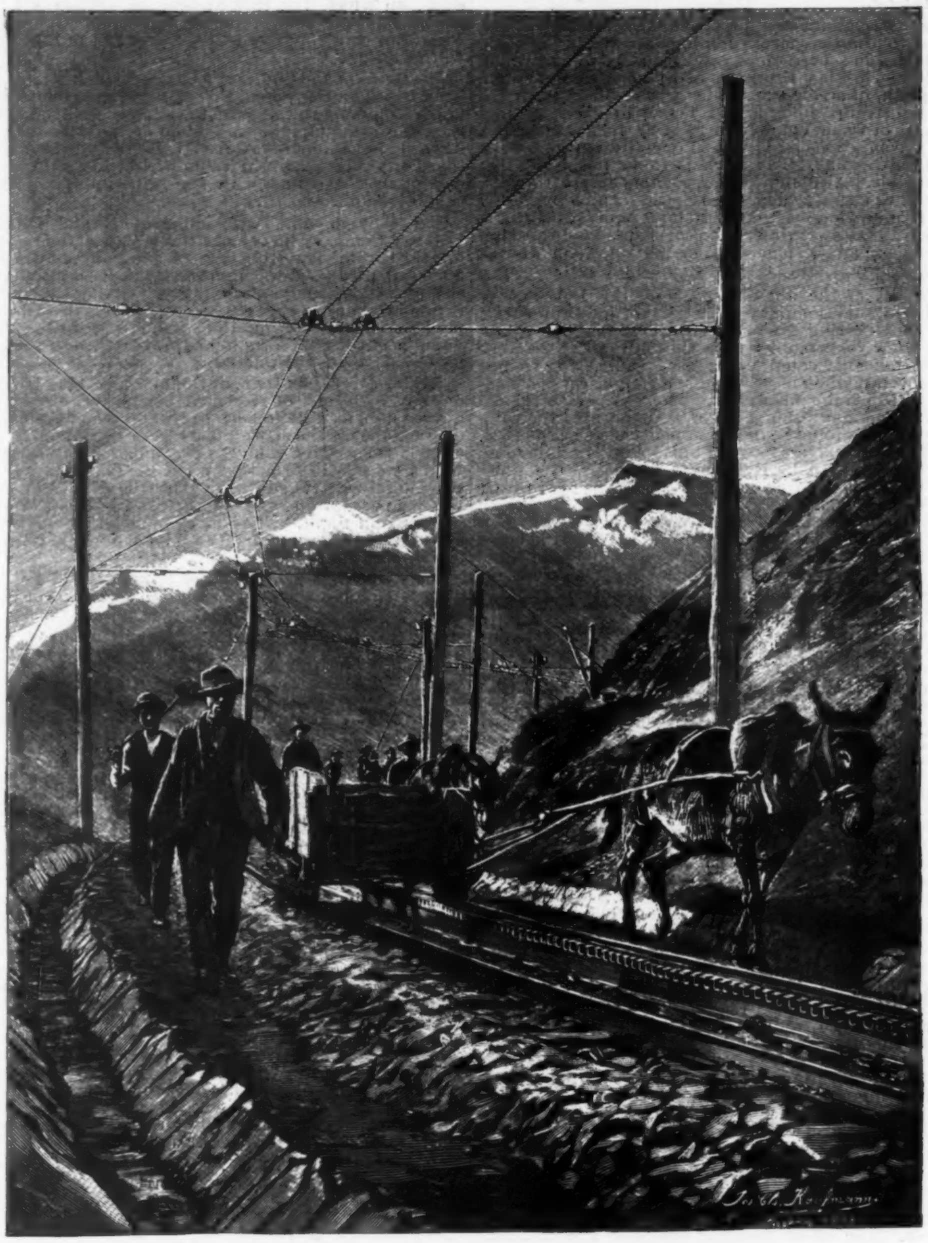
First of all, the objection was raised that a railway on the Jungfrau, sparkling immaculately in her garb of eternal white, would be a desecration of nature. Certainly, there are already too many mountain-roads in Switzerland. I cannot see the smoking, puffing locomotive crawling over the idyllically beautiful Wengernalp without thinking of the past, of the time when the ascent could be made only on foot or on horseback, and when a brightly animated picture of a fresh, happy little race of wanderers was presented, which harmonized far better with the sublimity of nature, with the melodious tinkling of the cowbells, and with the continual thundering crash of the avalanches, than the muffled and coldly reserved railway passengers, who seem as wearisome as they are wearied. And what ugly lines the railways themselves produce in the splendid landscapes!

Another objection is, that the air at great elevations would undermine the health of many Jungfrau tourists. A journey up into these higher atmospheres is of course not to be recommended to persons who are afflicted with certain ills, or who are particularly sensitive to the effects produced by the rarefied air of great elevations. At the starting point of the railway, however, a physician will be stationed, and placed at the disposal of those who know not whether they would be affected by the journey, and who wish to ascertain their physical condition before ascending. Moreover, the ascent to the summit will not be made without interruption, but the passengers will be able to leave the train at five intermediate stations. These stations will be hewn out of the rock, and the ceilings will be supported by stone pillars. The stations will be provided with window-like openings similar to those of the Axenstrasse on the Vierwaldstätter Lake. Walls, ceilings, and floors will be covered with wood, and the stations will be illuminated and heated throughout by electricity. In addition to the apartments of the attendants, each station will contain a restaurant and sleeping-rooms for travelers.

But, is it possible to build such a railway? Men experienced in these matters have declared that not only is it possible, but that the construction should present no great difficulties, since the road will be constructed within the mountains themselves, and will be protected from snow or ice.

Starting from the station of Kleine Scheidegg, reached by the Wengernalp railroad, and situated 8,770 feet above the sea—one-half of the elevation of the summit of the Jungfrau—the railroad runs first toward the Eiger glacier, passes through Eiger and then under Mönchsjoch and Jungfraujoch up to the heights of the Jungfrau, the highest point of which will be reached by an elevator. The following stations have been definitely fixed: Scheidegg, 2,064 m. (6,770 feet), elevation 0·0; Gletscher, 2,319 m. (7,606 feet), elevation 2·0 kilometers (6,561 feet); Eigerwand, 2,815 m. (9,233 feet), elevation 4·0 kilometers (13,122 feet); Eismeer, 3,160 m. (12,365 feet), elevation 5·6 kilometers (18,372 feet); Mönch (stopping place), 3,352 m. (11,985 feet), elevation 8·6 kilometers (32,214 feet); Jungfraujoch (elevator), 4,075 m. (13,366 feet), elevation 12 kilometers (39,368 feet); Jungfraukulm, 4,166 m. (13,634 feet). The entire road will therefore be 12 kilometers (7·45 miles) long. The grade is never to be greater than 25 per cent. and the ascent is to be made in exactly 100 minutes.

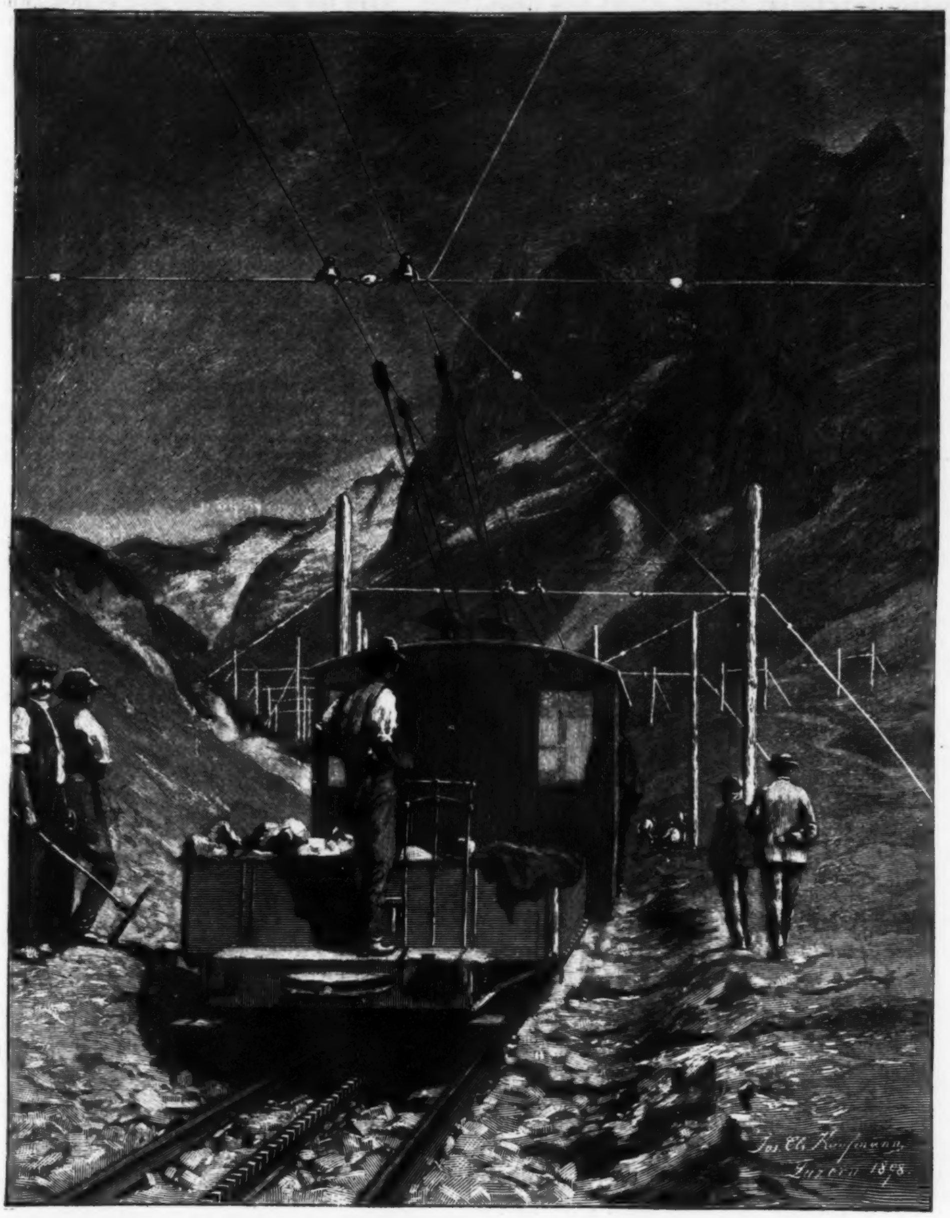
The road is operated by electricity generated in the valley of Lauterbrunnen and conducted up by naked wires at a tension of 7,000 volts. This current also drives the drills in the tunnel. Each drill comprises a vertical frame with two guide-posts between which the drill-holder, adjustable to all sides, is arranged. From the drill-holder, the drill projects. With each revolution the drill removes 2 mm. (0·078 inch) of the stone,



SLED RUNNING ON THE COMPLETED UPPER SECTION OF THE RAILWAY.

A VIEW FROM THE EIGER TUNNEL.

ELECTRIC DRILLS AT WORK IN THE EIGER TUNNEL.



ELECTRIC CAR PULLING A DIRT CAR.

and in about ten minutes bores a hole one meter (3·28 feet) in length. A longitudinal aperture extends through the drill, through which aperture water flows into the hole and serves to keep the drill cool, as well as to wash away the powdered rock. As soon as the drills have bored twelve holes in the roof, floor, and two sides of the tunnel, the machines are removed and blasting begins. Into each hole dynamite cartridges are dropped, and the fuses connected with the cap. The laborers in the tunnel all hurry down the hill, through the adit, and presently the explosions thunder forth. As the removal of the rock which has been blasted requires considerable time, the mines are daily fired only three or four times, equivalent to a daily advance of three to four meters (10 to 13 feet). Excavations are hence being made at a comparatively quick rate; but the work, it has been computed, will not be completed before the end of six years. The tunnel will be throughout 4·25 meters (13·94 feet) in height and 3·6 meters (11·808 feet) in width.

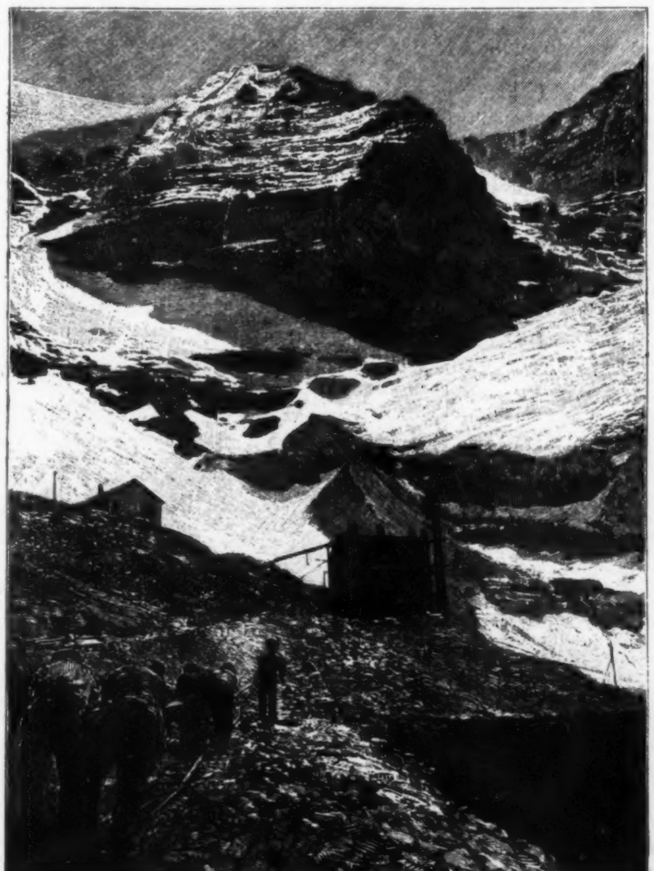
Electricity is also used in disposing of the water; for, with its assistance, ice and snow are melted, food is cooked, and in winter the workmen's huts are heated. The time is coming when the engineers with their 300 laborers, mostly Italian, will have become snow-bound up in the mountains. The electrical conductors connected with a telephone will then constitute the only means of communicating with the "lower world." A still larger generating station to be built in the valley of Grindelwald will add its power to that of the Lauterbrunnen power-house; and both together will produce power sufficient, not only for the needs of the road, but also for the production of most brilliant light effects. Upon Jungfraukulm two giant search-lights are placed, of hitherto unequaled power. One of these search-lights may be operated by the tourists who visit the Jungfrau by night, and the beams thrown upon the neighboring mountains or into the chamber of some sleeper far down in the valley. The other light will serve as a kind of lighthouse, visible from the cathedral of Strasburg and from the cathedral of Milan.

The question naturally arises: Will the undertaking be profitable? Men would probably not invest their money in a railway, if they were not assured that the railway would prove successful. To be sure, there are other mountain railways in Switzerland, but none of them is of such interest as the Jungfrau railway. The forty francs which will be charged in order to ascend the Jungfrau are, however, too large a sum for so brief a journey.—Illustrirte Zeitung.

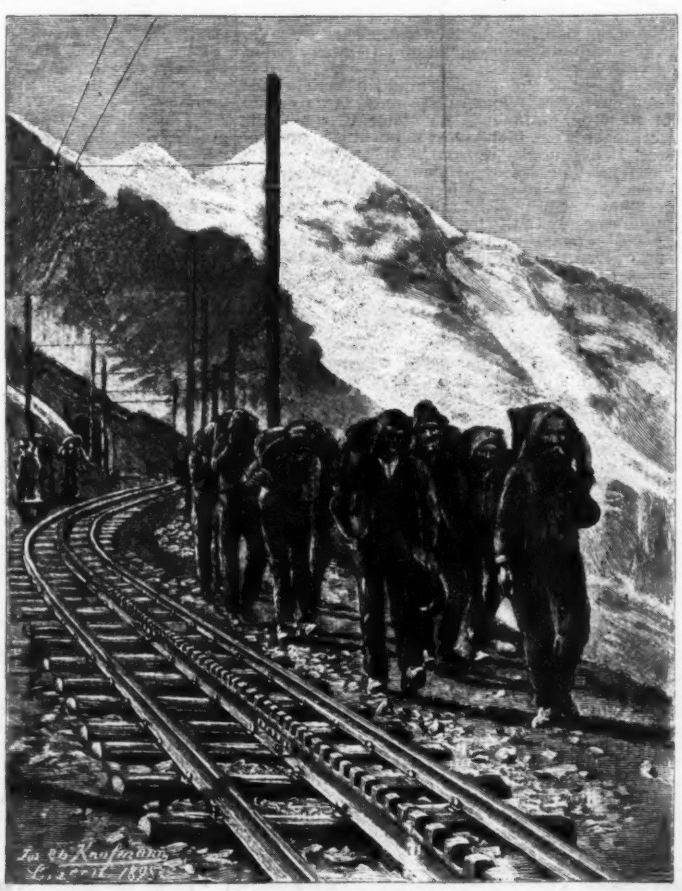
Mr. Alfred Harmsworth presided in London, November 28, at a meeting of the shareholders of his afternoon newspaper, The Evening News, and made some interesting remarks on the Spanish-American war and journalism. He said:

"The American war did not prove a source of revenue to the newspapers. War correspondence from Cuba cost The Evening News £300 ($1,500), and the results have not paid the bare expenses. The first week the sales bounded up an extra 100,000 copies per day, the second week they fell off heavily, and the third week they returned to their normal figure. The smashing of the Spanish fleet off Santiago failed to move the circulation by a single copy.

"The fact is that the English people never regarded the contest as a serious affair. They could not conceive it possible that folk of the same name and the same blood as ourselves could disgrace our race by suffering defeat at the hands of a Latin people."



EXCAVATING NEAR THE EIGER GLACIER.



ITALIAN LABORERS CARRYING CEMENT.

IN THE LAND OF GINGER—JAMAICA.*

By F. B. KILMER.

The books state that "Zingiber officinale, Roscoe (Amomum zingiber), is a native of Asia, and that it has been introduced into most tropical countries, and is now found in the West Indies, South America, tropical western Africa, and Queensland, in Australia." But the vial handed over the drug store counter, even though it may contain a weak decoction of pepper, will invariably be labeled "Jamaica Ginger." In these notes we shall, therefore, study this plant as seen in its popular habitat, thus keeping in sympathy with the West India planter, to whom the only known spot where ginger grows is in his sunlit garden.

In the track of the ocean steamers sailing from New York or Liverpool toward the Southern Continent, as they pass from the cold gray waters of the Atlantic into the warm blue waters of the Caribbean Sea, at a point in the Windward Passage 100 miles west of San Domingo, 90 miles south of Cuba, lies Jamaica. Donnelly created his island of "Atlantis" in these waters. Assuming his story to be true, St. Jago, the gem of the Antilles—Ginger Land—is a favorable location for his Eden. By a vivid imagination we might, from the present inhabitants, trace a lineage back through Ham, and arrive at a picture of Adam planting ginger in the first garden. As the traveler approaches Ginger Land he is impressed with the magnificence and beauty he sees outlined against a perfect sky. Terrace upon terrace of mountains upon mountains spring into view, dark purple mountains, rent by fissures, jutting into the blue heavens. The shores are covered with lovely green down to the water's edge; here and there a white spot, completely embowered in foliage, marks the plantations and settlements. Columbus formed a relief map of this island for his queen by crumpling a piece of paper in his hand. The landscape of Ginger Land is truly crumpled but picturesque, and the ginger plant grows luxuriantly on the steep sides of its crumpled elevations, from 2,000 feet up to the lofty summits of the blue mountain range. In gorges, in romantic glens, sinks, cockpits, valleys, through the ages there has been deposited a rich, humus soil. This is drained by innumerable streams, along the banks of which, among everblooming tropic flowers, ginger finds a congenial habitat.

One of the essential requirements for the growth of this plant is, sunshine—Old Sol ,is here young, bright, and active.

Another requisite for growth—moisture—is also here in plenty. In some portions 281 inches, or 23 feet, is recorded as an annual downpour. In the "ginger district" 88 inches, or over 7 feet, has been the mean annual rainfall for the last twenty years. (In a report made by one of my correspondents in this district, October, 1897, 47 inches, or nearly 4 feet, of rainfall was recorded in sixteen days.) While ginger grows at suitable elevations all over the island, it is mainly produced in the central western portion, along the borders of the parishes of Westmoreland, St. Elizabeth, Manchester, Clarenden, Trelawney, and St. James. The underlying soil of this district consists of white and yellow limestone, with trapean formation; this is covered in some of the nooks or valleys with a pulverulent mould or loam deposit several feet in depth. The plant grows luxuriantly in such soil, but apparently will not thrive in marshy soil, nor where there is present more than 10 to 20 per cent. of clay or 30 per cent. of sand. The government returns for the whole island give only about 250 acres of land devoted to ginger. This amount of acreage would not yield the crop harvested. But the real cultivation is not in acres, many cultivators having beds varying from 6 feet square up to the size of a building lot. A few cultivate from one to six acres. Large plots are very rare. For the most part it is put in the ground in any convenient spot, alongside pineapples, yams, cocoa, cassava, or other plants, often in the midst of a dense growth of bush or weeds.

In the statistics of this fertile island this article does not figure in pounds, shillings, and pence as largely as do some of its other products. Economically speaking, however, ginger is one of its most important articles of commerce. In my judgment, from 25,000 to 50,000 of its people are more or less dependent upon the ginger crop for such ready money as is essential to maintain their existence. The cultivation and gathering of this drug are largely in the hands of that peculiar class of West Indies peasants known as Quashie. Quashie is the title given the snuff-colored and brown people, as distinct from blacks, who make up nine-tenths of the inhabitants of the West Indies.

Though I know him well, it would be impossible to paint Quashie in words. To appreciate him, one must be in his actual presence. From a northern standpoint he is poorly equipped for the battle of life; he is simple-hearted, unambitious, and intellectually poor. Life to him is not serious, nor very earnest. It is more like a sunny dream. He lives in a hut far back from the road, a home bowered in tangled foliage brilliant with flowers. It is one-storied, one-roomed, unfloored, thatched with palms, opening all around, plenty of ventilation, but it is orderly, clean, and tidy. He has a buxom mate, numerous daughters, but few sons. Like him, they are all symmetrically cast, clean, and full of tropical vitality. Food is more than abundant; it drops from the trees and springs up from the ground. Ever so few shillings pay the taxes and supply clothing and all other wants, whether of necessity or luxury. He owes no man and no man owes him. Thus, in humble surroundings, the typical ginger planter lives in more independence, ease, and contentment than any dispenser of Jamaica ginger may even hope to attain.

The ginger planter is not given to taking in knowledge or giving out information. Long and vigorous cross-questioning will, in the end, only elicit the fact that he "doesn't rightly know" anything about ginger, or how much will be his own or his neighbor's crop. To the price of crop prospects, improvements in cultivation, difference in quality, he gives little thought or care. He divides ginger into "blue" and "yellow" from the color of the rhizome. These are also known as, respectively, "turmeric" and "flint." I was unable to see any botanical difference in the plant producing the two different colored root stalks, and many intelligent planters were unable to distinguish the kinds without first examining the root. If anything, it seemed to me that the blue was a degenerate species. The root of the blue is hard and fibrous, yields a much less proportion of powder, is less pungent, and, therefore, less valuable commercially.†

There is also a division into "plant" and "ratoon" ginger. Plant ginger is ginger that is planted each season; ratoon ginger is really a product of laziness. It is a return crop, secured by leaving a part of the "hand" containing a bud in the ground when the crop is harvested. Ratoon ginger is much smaller in size of hands than the planted, and loses each year in flavor, each successive year being less and less in amount.

GINGER PLANTING.

Ginger is planted in March and April. The planting process consists in burying the divided fingers, each division containing an "eye" or embryo, in trenches or holes a few inches below the surface and about a foot apart, similar to the process of planting potatoes. The small grower simply digs a hole in a convenient spot. The thrifty planter first burns over his plot to destroy weeds and insects, then plows and lays the plot out into beds and trenches.

The growing plant needs plenty of sun, and the weeds and bushes must be kept down. This latter is a perplexing problem, unless the weeds have been destroyed before the ginger has been planted. If the weeds are pulled or the ground disturbed while the plant is growing, water is apt to settle around the roots, and this rots them. The average Jamaica planter is not given to work, and he generally lets the weeds and ginger solve the question by fighting it out for themselves.

The reed-like ginger plant, with its leafy stems, grows sometimes to a height of five feet; its cone-topped flowering stems reach from six to twelve inches, and, in a well cleaned field, make a pretty show when in their September bloom.

On wet soil and during very rainy seasons the root is subject to what is termed "black rotten." This is a rotting induced by warm, soggy soil. The root swells in spots, fills with water, turns black, and emits an offensive odor. In this condition it is attacked by insects and worms, which has given rise to the belief among the planters that the rotting is caused by a so-called ginger worm. (It is possibly a fungus disease.)

Growing ginger must be well watered. Irrigation is practiced to a limited extent, but in most of the parishes this is unnecessary, as the rainfall is abundant. Fertilization, though highly important, is rarely attempted, partly owing to the small profit, but largely owing to the customs of the country. The most that is ever done is to plow in the weeds and cover the ground with banana trash. Rarely will the planter ever gather up the manure from his live stock and throw it on the ginger bed. There are no stables used in Jamaica, therefore no such thing as a compost heap. Sea weeds and watering the beds with sea water have been tried experimentally with good results; but no matter how large sized roots or how fine a quality would be yielded, the average planter would not take the trouble to work his ground in a scientific manner.

An all-important feature is the rapid impoverishment of the soil that follows the ginger culture. One planter told me that only ferns would grow on the soil after exhaustion by this crop. There is thus a constant demand for virgin soil to secure the best paying crops. This is attained by sending valuable timber up in smoke; as one authority tersely expressed it, "Dried up streams, general barrenness, in fact, a wilderness, mark the progress of ginger culture."

The situation is clearly summed up by Mr. William Fawcett, director of public gardens for Jamaica, from whose report to the Honorable Colonial Secretary I quote:

"The soil which produces the very highest quality ginger, realizing, perhaps, £10 per cwt. in the London markets, is the very deep black soil of virgin forest. To grow ginger under this condition involves the destruction of large areas of forest. Magnificent trees six feet in diameter may be seen in some districts lying rotting on the ground, while the ginger cultivators have gone further to the center of the island, abandoning the woodlands already cut down. The plan adopted in clearing a forest is for a cultivator to invite ten or twelve of his friends to a 'cutting match.' He provides food and drink, and the laborious work of felling trees is carried on merrily and without much expense. Afterward fire is put and the place is burnt over. This burning is considered very important, as much so as the virgin soil.

"Probably its importance is due principally to the deposit of potash and other mineral matters contained in the ashes, but the fire will also sweeten the ground, correcting sourness; and, moreover, it destroys insect pests. Some cultivators will only grow ginger in freshly cleared woodland, and next year they move on to a new clearing; but although in this way they get very fine ginger, it is at the expense of forest land which would require a heavy outlay and perhaps a term of one hundred years to restore. Albert Town was not long ago a great center for the cultivation, but I was told there that growers had already got as far as fourteen miles further inland.

"Ginger can be, and is, grown in many places year after year on the same ground. An intelligent cultivator at Borbridge stated that he knew of ginger growing for forty years in the same patch. Sanford Town is a German colony, and one of the original colonists, Somers, an active old man of eighty years of age, has been cultivating ginger and arrowroot there since his youth. He and the other colonists have been in the habit of planting a small patch one year, leaving it to ratoon as long as it was profitable, then throwing it up or growing other plants until, after a term of years, they again plant the same patch with ginger. This is an irregular rotation of crops; 'plant ginger,' the product of planting, is of better quality than the ratoon, and the ratoons in each succeeding year are inferior. When the ground is too poor to grow 'white ginger,' the 'blue ginger,' the inferior variety, can be grown.

"More depends upon the curing of ginger, considering the crop as a livelihood, than soil. I believe that the badly cured ginger brought sometimes to the market is due to wet weather rather than to want of care.

"The export of ginger is, on the whole, on the increase, but if this is accompanied by the gradual destruction of woods and forests, it is not a subject of congratulation."

An examination of the exhausted soil revealed the fact that it was deficient in organic matter, lime, phosphoric acid, and soda. Attempts made, at my suggestion, to supply these deficiencies by the use of market fertilizers of various kinds were not productive of any favorable results. Stable manure alone resulted in a failure, as likewise did the use of a bat guano found on the island. The use of marl, especially when mixed with stable manure, was a partial success.

The Jamaica Agricultural Society in 1895 began a series of practical experiments, which are still in progress. Their first results, gathered in February, 1897, were somewhat affected by a drought in the previous November. Upon a limited area of wornout land, which, in a check experiment, gave no return, they secured a crop which would be equivalent to over 2,500 pounds of cured per acre, and the product was of extraordinary size and quality. The fertilizer which aided in bringing this result was a mixture of marl with a compound fertilizer made up of about ten per cent. each of soluble phosphates, ammonia, and potash salts. These results were very encouraging, and the society have extended them by securing larger plots, giving aid to planters in the way of furnishing fertilizer, etc., returns from which were gathered in the spring of 1898.

The solution of the problem of reclaiming land exhausted by the ginger and other crops and the prevention of the further wasteful destruction of valuable soil is, in Ginger Land, one of great moment. There are in this fair island thousands upon thousands of acres of abandoned land lying within easy reach of roads and ports. Much of it has been abandoned because the soil has been exhausted by ginger or coffee. If, by suitable tillage and manures, it can be reclaimed, great benefits to the inhabitants will follow.

Ginger, as we know it, is the root stalk of the plant. The root proper or root fibers are about one-half inch long, not very numerous, dying off as the rhizome advances, and leaving a slight scar. As regularly shaped hands, with more or less straight fingers, command the higher price in markets, experiments were made to secure a regular shaped growth. Owing to the peculiarities of the native planter, instructions were not closely followed, and the results were unsuccessful. The fact was developed that a sprout starts from the parent eye, and from this stem, in turn, lateral shoots or branches develop in pairs. The side branches again develop in pairs, these pairs generally alternating to opposite sides. It was found that if the soil was well worked and pulverized before planting, the growth was straighter than when planted in hard soil. Some difference was noted also in the condition of the parent plant. If this was well developed and vigorous, the resultant root stalk was of a better type than where the parent was small, gnarly, and crooked. The Botanical Department is now experimenting with selected plants.

GATHERING THE GINGER CROP.

Ratoon ginger is gathered from March to December, but planted ginger is not ready for digging until December or January, and from then until March is the "ginger season."

Ginger is known to be ready for harvest when the stalk withers. This begins shortly before the bloom departs. The rhizomes are twisted out of the ground with a fork. In this operation every bruise or injury to the hands is detrimental to the market value. There is quite a knack in doing this, and it takes long practice to become expert.

The hands are thrown in heaps, the fibrous roots are broken off, and the soil and adherent matter removed. This must be done quickly after removal from the earth, for, should the ginger be dried with the soil and roots still adhering, the product would not be white, and, if it lies in heaps before drying, it will mould. The custom is to throw it immediately into a dish of water. It is then ready for the uncoating or peeling operation. This is done by hand. A planter who has any quantity of it on hand will make a "peeling match" by gathering his own family and whatever help his neighbors can afford. The ginger season thus becomes a time of merry-making.

It was my privilege and ,a part of my studies to be present at one of these peculiar harvest home gatherings in Ginger Land. I was given a point of vantage overlooking the dancing hall, which, on this occasion, was the cement floor of the barbecue. The light of a few sickly lanterns, a smoky torch, and the hot glare of the tropical moon gleamed on the dusky men and maiden ginger peelers. Their dresses were marvels in color, the men in somber black, except for white vests and rainbow sashes. Against the dark-skinned forms of the gentler sex were brilliant reds, yellows, greens, and blues. Their skirts stood out balloonlike, stiff with cassava starch. Trinkets of silver and gold were very heavy and plentiful. They danced to the music of squeaky accordions, clapping of hands, and the plaintive, wailing, but musical voices of the onlookers. There was plenty of noise—plenty of ginger in that dance. The native "spiritus saccharum jamaicaiensis" was dispensed freely, but I have seen less orderly merry-makers in our own land of culture, and in all that excited, hot-blooded crowd, not one was drunk or committed any flagrant breach of propriety. Past midnight I lay down on the only bed that the hut of my host, Quashie, afforded. At intervals I awoke, to find that the ginger dance was still on. When the first rays of light came over the blue mountain peak, there, on the bed, under the bed, sprawled in heaps, over the floor, were the exhausted dancers fast asleep. But, for all they had made such a night of it, before the sun's rays had entered the cabin they had bathed their

* Major portion of a paper read at a regular pharmaceutical meeting of the Philadelphia College of Pharmacy and reprinted from The American Journal of Pharmacy.—From The Pharmaceutical Era.

† I found some shippers in Jamaica ports who were exporting the undried "blue" ginger to supply the demand for green ginger as used in pickling and preserving.

bodies in the cool spring, taken a cup of coffee, and were fresh for the day's work.

PEELING GINGER.

Ginger peeling is an art, and there are many expert peelers in Jamaica. The ginger knife is simply a narrow-edged blade riveted to the handle. In large operations, an expert peels between the fingers of the hands, less experienced hands peeling the other portions. Examination of a transverse section of ginger will show the importance of the operation. There is an outer striated skin, under which there are numerous layers of very thin-walled cork cells. This layer contains numerous oil cells, the oil cells being most numerous at the bud points. The oil contained in these cells, in specimens fresh from the ground, is almost colorless, very pungent, and exceedingly aromatic. It becomes yellow very quickly on exposure to the air, and, even upon drying without removing the epidermis, its delicate aroma is found to be fleeting. On drying the ginger, the contents of these cells appear as a yellow, pitchy mass. (It has been stated that this coloring matter is identical with that of Curcuma.) As this cork layer is the seat of the greatest amount of oil and resin cells, it will readily be seen that the deeper the peeling, so much the more of these substances will be carried away with the epidermis, and more cells opened from which these principles may exude.*

As fast as peeled the roots are thrown into water and washed. The purer the water and the more freely it is used, the whiter will be the product. Generally a very little water washes a great deal of ginger. The hands are peeled during the day, and allowed to remain in the water over night. This water acquires a slimy feeling, and, if concentrated, becomes mucilaginous and acquires a warm and aromatic taste. The natives claim that this process soaks out the "fire and poison" from very hot ginger. I placed some pieces in a stream of running water for twelve hours, and succeeded in making them several shades lighter in color. This sample proved to be less pungent to the taste, and it is quite possible the force of the water carried away some portion of the aromatic principles.

A few planters use lime juice in the wash water. This gives a whiter root, having some solvent action on the coloring matter, but, as the lime juice contains saccharine and pectose matter, it prevents drying, and mildew follows. In another experiment I supplied the natives with citric acid, vinegar, and acetic acid. They all worked fairly well, citric acid being the best whitening agent, but it was reported that the process was expensive and troublesome.

It is generally stated that ginger is deprived of its coat by being plunged into boiling water before being scraped. This practice is not used to any extent in Jamaica. Its effect is to swell the starch and bassorin-like gums. I found that after keeping the freshly peeled root stalks in boiling water for an hour they were considerably swollen and the steam was filled with the aroma of the ginger. Under this treatment the coating comes off easily; but, if the action of the boiling water is prolonged, the starch and fiber are acted upon, the product dries hard and the color is darkened. In fact, what is known as "black ginger" of the market is the result of the process. Ginger is found in the market coated with calcareous matter, such as carbonate of lime, etc. This is said to fill a demand for "white ginger." Such a proceeding is apparently unknown among the planters. Well cured ginger has a decided white coating and that is all they know about it.

It has been stated that it is a common practice to bleach ginger with the fumes of chlorine or sulphurous acid. It may be done in other parts of the world, but no instance of it is known in Jamaica.† There is scarcely a planter with intelligence enough to use, or who would take the pains to employ, such a process. I tried chlorine gas as a bleaching agent, but at best the product was of a dirty yellow color. By using the fumes of burning sulphur, the whole being partially inclosed in glass, the heat of the sun aiding in the experiment, the ginger was whitened and mildew prevented. I found on trial that it might be of service to place the ginger in a weak solution of chloride of lime before drying. This would aid in bleaching and prevent mould.

CURING GINGER.

After washing, the process of drying follows. The tropical sun is the drying agent in all cases. Large operators have what is called a "barbecue." This is a piece of ground several feet square, leveled off and laid with stone and the whole coated with cement. It is placed so as to receive the greatest amount of sunshine. The small planter uses what is called a "mat," consisting of sticks driven into the ground, sawbuck fashion, and across these sticks are laid boards, palm, banana, or other large leaves; oftener than otherwise, the place for drying is a few palm leaves spread upon the ground.

Careful handlers put their ginger out as the sun rises, and turn it over at midday, taking it in at sundown. Rainy or cloudy weather invites mildew. It requires 6 to 8 days for the root to become thoroughly dry. I made several tests to ascertain the loss in weight by drying in the sun, and found the average to be nearly 70 per cent.

Ginger dried in the sun for the market examined for moisture gave the following results:

Six samples, well dried specimens, showed a further loss when dried at 100° C. as follows: 7·2, 8·5, 8·9, 9·5, 10, 11, 12 per cent.

Several poorly dried specimens, some of which were damp and mouldy, gave from 15 to 26 per cent. moisture when dried at 100° C. During the progress of my attention to this subject, several attempts were made to utilize artificial heat in drying ginger. Such a course would, in some respects, be a very desirable one.

In a portion of the island given almost entirely to the cultivation of this product, a few years ago a wet season prevailed. It was impossible to dry the crop in the sun; as a consequence there was a loss of the crop, followed by considerable distress among the planters.

During my observations an attempt was first made to dry without removal of the skin coat. This, if successful, would have meant the saving of considerable labor. The product was quite dark, the flavor not as good as that of the sun dried. By removing a part of the coat the drying was hastened. Dr. A. G. McCatty, a practicing physician and owner of a plantation, at my suggestion placed in operation an American fruit evaporator. It was necessary to use wood as a source of heat, and, partly owing to the high temperature and partly from ignorance of the operator, the product so far has been rather poor in quality, the color many shades darker, much of the aroma was lost, and a smoky, burned flavor acquired. Other planters are trying the process on this year's crop.

A curious incident resulted during these experiments. The natives, through prejudice against innovations, boycotted the drying apparatus, and refused to furnish supplies at any price. Experiments were made with calcium chloride as a drying agent. The result did not equal samples produced by the native method of drying in the sun. Attempts made to dry the ginger after first slicing, as might be expected, resulted in great loss of flavor and pungency. My conclusions were that, when well conducted, the native method of careful peeling and curing in the sun would produce a handsomer and a better product than any process yet suggested.

These observations were not undertaken with a view of making any complete analysis, and it was found that a microscopic examination by expert judges was far more reliable than any assay that could be made with limited facilities present in the ginger fields. A few such examinations were made as follows:

Ethereal Extract.—Exhaustion of the ginger with ether in a Soxhlet extraction apparatus. The resultant extract, after evaporation of the ether, was dried over sulphuric acid to remove moisture. From this extract the volatile oil was calculated by the loss on drying the ethereal extract at 110° C. for three hours. The only results from this process that seemed to be of value were that the finer grades, when carefully dried, contained a higher percentage of volatile oil.

Ginger dried without removing the peel gave somewhat higher results as to volatile oils than the peeled. The loss of this constituent was greater in a product dried by artificial heat than when dried by sun. The amount of volatile oil found by the aforesaid process was, lowest, 1 per cent.; highest, 3·20 per cent. The results as to ethereal extract, exclusive of volatile oil or from alcoholic extract from the ether exhausted residue, seemed to be of little value, the different specimens giving such greatly changing amounts as to afford no guide.

In these experiments some observations were made that were interesting, though of no particular value. In the extracts from ratoon ginger there was evidently a more fiery taste and less flavor than in the planted ginger. This was also true in regard to the extracts from the blue and yellow varieties, the yellow having a much finer odor and taste. Upon the addition of water to these extracts in sufficient amounts to precipitate the dissolved resins, it was observed that in the case of the well cured specimens of plant ginger a delightful aroma was imparted to the water, a true ginger flavor, without fire or pungency. But in extracts from old ratoon ginger, from mildewed specimens spoiled in drying, this aroma was greatly changed, becoming musty and weak, the taste in some instances being decidedly bitter. Ninety-five per cent. alcohol was found to give better results as to flavor of extract than that of lower strength.

MOVING TO GINGER MARKET.

When the native tropical sun has fully dried the ginger crop, it is stored in heaps for market day. By unchangeable Ginger Land customs, there are certain days and times to carry products to market. There are banana days, pineapple days, pimento days, and ginger days. The buyer must take in his supplies on these days or go without them.

The ginger crop is carried from five to forty miles to a place of sale. In the proper season, along the white-paved roads, from the cool, refreshing hours of the morning far into the night, ginger may be seen moving to market. The richer planter, with a lace bark rope, leads a heavily laden donkey with panniers heaped. Sometimes piled high on either side, above the ginger, are pineapples, plantains, yams, and strange looking fruits; over all are bunches of knotted sugar cane and nets filled with green cocoanuts. But by far the greater portion of the ginger, and every other crop, is moved by head loads.

Troops of Jamaica's brown and yellow daughters are seen trudging up and down hills under the terrible sun with a load of a hundred pounds or more at graceful equipoise on their gayly turbaned heads. All have their garments kilted up to their bare dark knees. These women have taken their colors from the fruits; their complexions are orange, olive, sapota, mango, deepening into a bronze-black. They are upright as darts, walk with a free, unhindered stride, without any swinging of the shoulders, impressing one greatly with their grace and elegance of motion. Carrying their heads like queens, without nod or turning, they cry out in a high pitched, musical key, to the bystanders, "Marningbuckra," and pass on, their naked feet making a great whispering sound over the smooth roadway. In a picturesque way ginger passes to the market town.

The market may be in the port town or at the cross-roads store. The sign at this latter place reads, in rather shaky characters, "Lisened to dele in Agricultural Produse," which is made to include rum, gin, and a general conglomeration of merchandise, not counting drugs and medicines. In this sort of place anything in the shape of hands and fingers is ginger, and is dumped into a barrel without any sorting, to be shipped to the port. Often the small shopkeeper is heavily in debt to the large trader in the port, and, when ginger is wanted, makes haste to get in as much as possible, regardless of quality.

IN THE GINGER MARKET.

The markets of these West Indies towns are the important centers of commerce. Here, in a large open space near the quay, a great hurry and clatter of brisk business proceeds under the beautiful blue sky and blazing sunshine.

Quashie requires much conversation to complete a bargain. One would suspect by the bustle and noise that the entire wealth of the island was changing hands every few minutes, but the truth is, the most prolonged and loud wrangle closes a transaction involving a minute fraction of a penny. There are a few benches or stalls under the market arcade, but they require a rental fee; so, for many, an upturned barrel outside constitutes a stall. Those who have no barrel pile their wares on the ground between their sprawling black limbs. It is a good place to study fruits and vegetables monstrous in size, with outlandish names, but luscious in looks. Many kinds of drugs are here in their primitive state, ginger in abundance. Nearly every other seller cries out:

"Buckrayouwangingafoobuy" (white master, do you want to buy ginger?)

These black people speak with a rolling current of vowels and consonants, pouring them out so rapidly that none but an acclimated ear can detach an intelligible word. The ginger is not weighed, measured, or counted, the standard is a "heap." A heap of ginger is a pile that enlarges or diminishes according to the law of supply and demand. If the hands are finely shaped and large, there are fewer in the heap; if they are small, dark, and snarly, the heap is made larger. If the price of ginger goes up in London or New York, it is because the heaps in this market have been made smaller. If the price goes down, these heaps have become larger and finer. The price of ginger in the drug exchanges of the world is the reflection of the changing size of these petty heaps in Ginger Land.

The ruling price in Kingston and Montego Bay for the heap is a penny-ha-penny (about three cents). Heaps purchased by me varied according to quality, but the average weight was from one-fourth to one half pound.

The buyers of ginger for shipping are expert and accurate. They grade, sort, and price with a quick eye and ready touch gained by years of practice. The highest grades are large sized hands of light and uniform color, free from evidence of mildew. This grade is brittle and cracks easily, but broken pieces depreciate the value. Buyers also require the hands and fingers to be firm and full, without wrinkles or spots. They generally assort into four or five grades, that which is shriveled and small being the lowest. The dark varieties form another, the heavy, tough, and flinty a third. These four are finally assorted by placing hands which are small but of good texture and color as one grade. The larger sized, well bleached hands into the highest grade.

The ratoon finger sorts generally bring the lowest price, as they are small, soft, and soggy, and lack flavor. Ginger gathered green shrivels much in drying, and is less aromatic and pungent than when fully matured. Ginger that has mildewed is spotted, and the mildew starts a decomposition that affects the flavor. Ginger put in bags or laid away before being thoroughly dried will mould and acquire a musty odor and flavor, which it is impossible to remove.

The largest sized hands are carefully selected by buyers and shipped to special markets, usually to England. I noticed hands weighing as much as eight ounces; many of them weighing from four ounces upward.

Ginger is packed in barrels for shipment.

ECONOMICS.

The amount of ginger exported from this island during the last ten years is shown in the following table:*

	Pounds.
1887	1,121,827
1888	1,141,877
1889	1,002,653
1890 (½ year)	554,193
1891	1,219,197
1892	1,822,531
1893	1,526,884
1894	1,672,384
1895	1,736,460
1896	1,960,609

The amount of ginger imported into the United States from all parts of the world in the years 1890 to 1894 was as follows:

	Pounds.
1890	2,328,825
1891	2,697,989
1892	1,431,295
1893	2,927,942

The yield and profit of the ginger crop depend somewhat upon the nature of the soil. In favorable seasons rainfall, sunshine, planting, care, and curing are also factors. An average yield can be estimated at from 1,000 to 1,500 pounds dried ginger per acre. In exceptional cases, 2,000 pounds have been gathered. There are planters in Jamaica who plant ginger here and there in patches, and gathering as little as 100 pounds in a year. Ginger is well adapted to the small planter, and admirably suited to the peasantry of Jamaica, who, by slow evolution, are passing from serfdom to manhood and independence.

The exact cost of producing this crop is difficult to calculate. The present output is largely the product of domestic labor, whose value is hard to compute; when this class of labor is hired, it becomes very costly. The figures in the following table are approximate only; as now conducted there is chargeable against the crop the item of rent, or tax (if the cultivator is an owner). The labor is mainly that of the family.

An approximate estimate of the expenditures and receipts on an acre of land planted in ginger are as follows:

Ground rent or tax	$5
Clearing land, plowing, and planting	40
Cost of plants	50
Digging and preparing	15
Peeling	45
Drying	25
Delivery at market	10
	$190
Fertilizer (if used)	50
Superintendence	20
	$260

Yield, 1,500 to 2,500 pounds (cured sugar), at 12 cents per pound, $180 to $300.

Viewed from this standpoint, the cultivation of gin-

* The Jamaica Agricultural Society has advertised in the United States and England the desirability of a machine or apparatus to be used in removing the coating from ginger. Experiments along this line are now being made.

† Bleaching by chemicals and coating with powders are market processes unknown to the planters.

* Figures obtained from the office of the collectors-general of Jamaica show that more than one-half of the crop is shipped direct to United States ports.

ger on a large scale would be far from remunerative. In this connection we may note that a Royal Commission appointed to investigate the depressed condition of the industries in the West India Islands have recently submitted a report to Her Majesty's government. Among the recommendations made was "The settlement of the laboring population on small plots of land as peasant proprietors." This corroborates our view that, from the Jamaica standpoint, it is better economy to allow the cultivation of ginger to remain where it is. The introduction of artificial heat for drying, machinery for peeling, will have a tendency to deprive the peasantry of a source of income, and this, so far as these investigations show, will not improve the quality of the product.

The Botanical Department, through its corps of agricultural instructors, is now going among the people and showing them exactly what may be done in the way of improving their methods of cultivation. The Jamaica Agricultural Society is conducting practical and extensive demonstrations to show the use and value of fertilizers. They have already an important bearing upon this crop. Information recently to hand states that the crop which was gathered in the spring of 1898 was the largest ever grown upon the island. This is due to the improvement in cultivation, together with an abundant rainfall. Unfortunately for the ginger planter, a largely increased production will tend to lower prices.

THE RACES OF THE PHILIPPINE ARCHIPELAGO.*

The subject to which I desire to ask your attention is the ethnology of the Philippine Islands. The ethnologists and the anthropologists always desire to study man, and must study man, in connection with his surroundings. I shall, therefore, begin with a brief sketch of the geography of the Philippine Archipelago, adding a few words upon its geology, and a few upon its history, before I venture upon remarks about the people themselves.

We are to-day celebrating the close of war, a war in which we have expended, in round numbers, $500,000,000; and, up to the present time, the only value which we have received in any way has been the island of Porto Rico; the only value which it looks as if we might receive is this island, unless we include the archipelago of which I am going to speak this evening. Porto Rico is a tropical island about half the size of the State of New Jersey. Its total valuation would probably be considerably under one-half the State of New Jersey as it stands to-day.

If we pass directly around the earth for one-half the distance of its circumference, on the same parallel of north latitude (about 19°) as Porto Rico, we reach the island of Luzon in the Philippines. It is, in fact, as I say, directly antipodal to Porto Rico. Luzon is the largest island in the Philippine Archipelago. It is somewhat smaller than the State of Pennsylvania. The next largest island in that archipelago is Mindanao, which is somewhat smaller than the State of Ohio. There are a number of other islands; indeed, the last count makes 1,430 islands named and inhabited in the archipelago of the Philippines. The archipelago extends in a direction from the north toward the south-southwest for the distance of about 1,000 miles, beginning about north latitude 20° and reaching within a few degrees (4° or 4½°) of the equator. Throughout this tropical sea the islands are scattered, of all shapes and all sizes, from the two largest (whose area I have given you) down to single rocks rising above the ocean.

The characteristics are, of course, highly tropical; and this is increased by a study of the soil and of the geological character of the islands themselves. The Philippine Archipelago lies adjacent to the great island of Borneo (the Sulu Islands being a stepping stone to Borneo) and, further on in the chain, next to Borneo, the islands of Sumatra and Java; but the geological formation of the Philippine Archipelago is different entirely in character. There is little doubt but that the three great islands adjacent, which I have named, belonged at one time to the continental area of Asia, to a continent which was erected there in the early Eocene times, and which in some convulsion of nature (probably in the Pleistocene or the late Pliocene period) were shivered and separated from the continent. Therefore we find all the geological characteristics of a continent upon those islands. Entirely different, however, is the geology of the Philippines; and this is in close relation, also, to much of its later history. The Philippines are recent in formation; they belong to the late Pliocene or Pleistocene times; the yare volcanic and coralline, and the coral insects which formed their corals are now living species in the adjacent waters.

* A lecture delivered at the Academy of Natural Sciences, Philadelphia, October 25, 1898, by Dr. Daniel G. Brinton, of the Academy. Revised by the author.

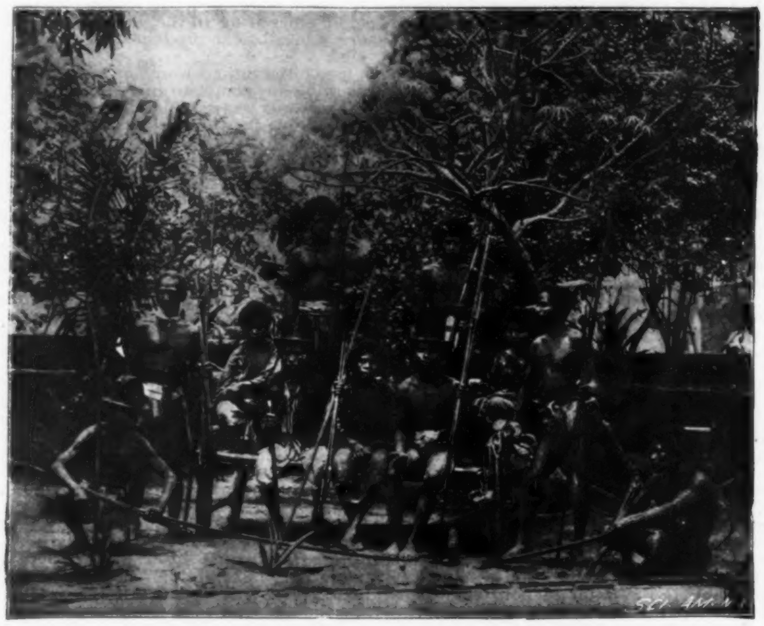
The general characteristics of these islands are, first, the great mountain chains which run through them and, second, the way in which they are broken up into small groups. We find there three parallel mountain chains, forming the island of Luzon in its northern portions; two being lateral, one central. These are the Cordilleras, as they are called; and they extend and form the boundary of the island, running down through the long peninsula of the Camarines. Luzon is very long compared with its area. These volcanic ranges extend south and build the islands of Samar and Leyte, and, running along the eastern shore of Mindanao, make the extensive peninsula of Sibuguey, which is projected in the direction of Borneo.

These mountain chains vary in Luzon from 5,000 to 8,000 feet in height, averaging from 3,000 to 6,000 feet. They are still higher in certain portions of Mindanao, and they contain various active volcanoes. The volcano in the extreme northeast of Luzon, called Cagua, is said to be the lowest active volcano in the world, something over three thousand feet above the sea; whereas, the volcano of Apo, in the center of Mindanao, is 10,800 feet high. It is to this volcanic character of the land that its extraordinary fertility is due; as it is well known that the sides and valleys of volcanic ridges are generally exceedingly fertile and rich; and that is the case with the whole of the Philippine group.

I need not call attention, specifically, to the number of these islands which intervene between Mindanao and Luzon. They are known as the Visayas Islands. One of them, Mindoro, the largest, is about the size of Porto Rico and half the size of the State of New Jersey, having an area of about 4,000 square miles. Palawan Island is remarkable in some respects as being probably the longest island of a similar width to be found in the world. It is 240 miles long and in no place over 25 to 28 miles wide—the crest of a mountain chain. In the extreme south occurs the peninsula of the Sulu Islands (lying between Mindanao and Borneo) and which were, no doubt, originally the stepping stones by which the population of the Philippines was changed from time to time by immigration from that direction. In the direction of Luzon this island lies in close contiguity to Formosa; and the small archipelago closely adjacent thereto is occupied by a character of population similar to what we find on the mainland of Luzon.

Referring to the Chinese, who occupy Formosa, I may add that our earliest historic knowledge of the Philippine Islands comes through Chinese sources. There are works in the Chinese language, dating from 1300 to 1350, describing the Philippine Islands—especially Luzon; and, for a certain period, Luzon was tributary to the Chinese—about the fourteenth or thirteenth century. The yoke was thrown off long before the Spaniards reached there by the Filipinos themselves. It first appears in European history when Fernando Magellan, passing through the straits which to-day bear his name in the extreme south of South America, crossed the Pacific and sighted the islands in this group—a small group north of Mindanao. Those he discovered in March, 1521, and claimed the whole of the archipelago for the crown of Spain. Spain, however, made no permanent settlement on any of these islands until 1570 or 1571, when Manila was taken as the capital. The Philippines have always since remained as part of the land of the crown of Spain, except for two years, from 1762 to 1764, when they were conquered and held for a certain length of time by the English, but given up afterward by an agreement at Paris—which looks somewhat like a formidable precedent.

Such, in brief outline, is the description of these islands from the point of view of the geographer, the geologist, and the historian. Let us now ask, what do they present to the ethnologist? They present some very curious problems. We find that in the interior of many of these islands there is a small black race called the Negritos, or the Aitas. They are much undersize, resembling almost pygmies, the average height of the adult male not being quite 5 feet—about 4 feet 10 or 11 inches. These Aitas belong markedly to the black or African race in appearance. They have woolly hair; their faces are prognathic; their color is black; they have the thin legs and the flattened tibiae



NEGRITOS OF MARIVALES—THE CHIEF AND HEAD MEN WITH HATS PRESENTED BY THE SPANISH.

NATIVES OF ABRA.

NEGRITOS OF MARIVALES SHOOTING FISH FROM AN INDIAN BOAT.

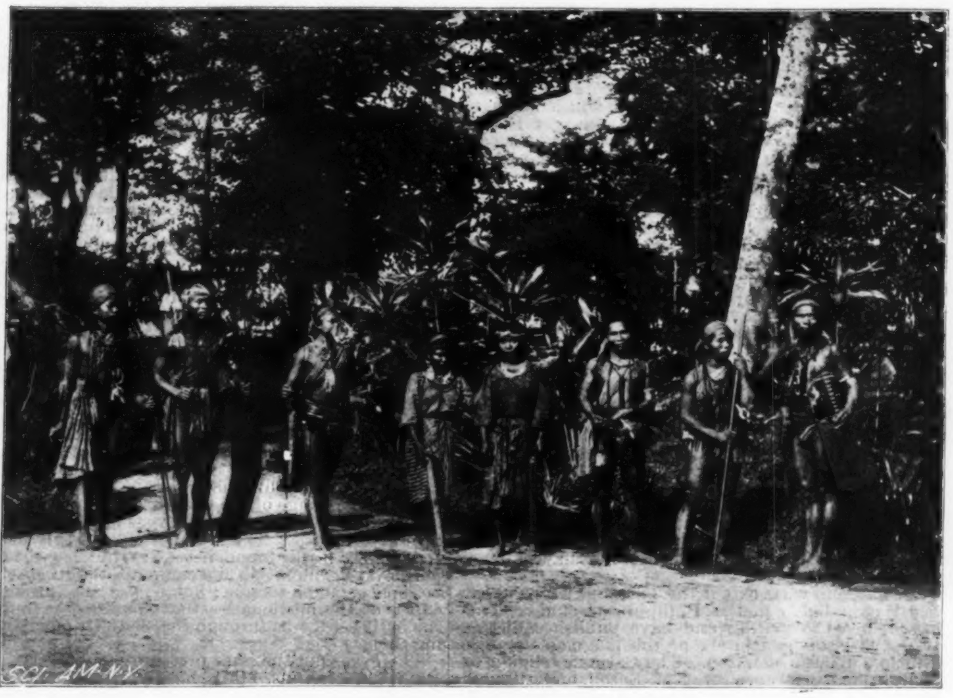
or shin bones that we find in the lowest type of the African race. They also differ entirely in language and characteristics from the rest of the population. The Negritos, however, are not numerous; and politically, they would count for nothing in discussing questions relating to the Philippines.

I have not told you about the number of populations which these islands possess. Spain has never made a complete census, nor even attempted to do so, of these islanders. The only census reports which we get from Spain relate to the taxable inhabitants, the census statistics not taking any others into consideration. Therefore, the various opinions about the number of inhabitants in the Philippines differ very widely; some I find placing them as low as 5,000,000; some, as high as 10,000,000. A careful calculation, however, it appears to me, would place the number about 6,000,000 in all. Of those 6,000,000 people, the pure Europeans are probably not over 10,000 in all, in all parts of the archipelago. I do not take into this computation the soldiers or those who are employed in civil government, because they are temporary residents; but the fixed, residential population of Europeans is not over 10,000. There is a large mixed population, of mixed European blood, which may be estimated at 15,000 in all, but not more. Therefore, of the 6,000,000 but a very small percentage can be called members of the white race. There are Chinese and Japanese, to the extent, probably, of 50,000 to 60,000 in all, scattered throughout the islands. They are usually occupied as merchants, seafarers, and, to some extent, cultivators of the soil. They, however, are largely in Luzon and on its western coast. The Negritos themselves, as I say, could not number over 8,000 or 10,000; and, probably, if we say 5,000 of pure Negrito blood, we should be fully up to the mark. There is, therefore, a vast proportion belonging to some other race. That race is what we call the Filipinos that you hear referred to. They are Malayan in language, in blood, and in appearance. There is no doubt, whatever, but that the original population of this archipelago was the Aitas, or small, black Negritos to whom I have referred. They were attacked forests. A Spanish missionary records that he went among those who were called the Dumagas, on the northeast coast of Luzon, and, having learned their language sufficiently to speak to them, he urged them to lay aside this vagabond life and settle down as did the white man (and many of the Malayans) and depend upon their own efforts for subsistence; but he was rather disconcerted to be told by their high priests that their religion forbade them to take any thought of the morrow, either as to what they should eat, or drink, or wherewithal they should be clothed; and following that out literally, they declined to accept the religion which the missionary brought them. He seemed to have heard that doctrine preached from a different quarter and therefore he had very little to say in answer to it. It is needless to state he failed in his attempt at conversion. The Negritos, however, as I say, are of little importance in a political point of view; they never could become so; and they are distinctly a decreasing and a vanishing race.

Of the first importance are the questions relating to the Malayan or Philippine population proper. The Malay immigration into the Philippines has been going on for about 2,500 years. It began about 600 years B. C., passing over by way of Borneo and coming from the Straits of Malacca and the mainland. We know that this must have been the case from a variety of reasons, not only from traditions, but from the character of culture that they brought with them. It is very noteworthy that in nearly all parts of the archipelago we find that the original Malayans brought with them an alphabet and a literature of their own, which, in many instances, have been retained to-day. This alphabet is one of sometimes twelve or fifteen characters, all relating to consonants, the vowels being indicated, as in the Hebrew, by points; and it was written, originally, either from top to bottom, or from bottom upward, or from right to left, reversing the way in which we write; but they have been instructed by the missionaries to write from left to right. Their characters differ very materially from our own, and have been traced by archæologists to a very ancient Buddhistic and names those whom he suspects. The head man summons all the suspected before him and directs each one of them to bring an armful of hay and throw it down before him in the open square of the little village. Then the hay is searched, and, not infrequently, the lost object is found there; but inasmuch as each has thrown his bundle of hay down, no one knows who the thief is; therefore he has the opportunity to return the stolen article without being discovered, and that is the real object of the trial, that the owner shall get back the object which has been stolen. If that fails, however, all the suspected are placed upon water, with the water up to their necks; they are told to duck their heads under, and the man who first puts his head above in order to breathe is recognized as the thief and punished accordingly. That form of justice seems to be very satisfactory.

The Tagals are a much more polished and cultivated people, and always were, than the northern tribes to whom I have alluded. They did not struggle when the Spaniards came and took possession of their land. They made no contest whatever; they accepted the Spanish supremacy without a war, and they received the Christian religion, which was offered to them, nominally, but they received it and gave up their own without any hesitation. They had an ancient literature, which was, unfortunately, lost; but they have created another which is now written in Latin letters and consists, very largely, of verses. They are remarkable poets; even the children in the streets will vie with one another in turning out verses, and the one who is slow, and who loses in the game, suffers some slight punishment from his fellows; but these verses are based upon a somewhat different principle from ours. They are in a certain sense rhymed, but the rhyme is that which is known as vocal assonance, which, to our ear, is no rhyme at all, though to the ear of one accustomed to the peculiarities of the Polynesian tongues, it is satisfactory and sufficient. For example, the four words, "man, sad, usual, perhaps," would not make a rhyme to our ear, but that is the character of the Tagalas' rhyme. It is the

NATIVES FROM TINGUIANES.



SAVAGES OF NORTH LUZON, WITH THEIR ARMS.

from two different directions: the Chinese, coming across from Formosa (which they had occupied about the sixth century of our era), drove the Negritos from the coasts into the interior of the mountains and into the mountainous districts; the Malay population, coming from Borneo and ultimately from the Asiatic continent (about what is called "The Straits") attacked the Negritos from another direction, destroying them altogether in the smaller islands and driving them into the interior in the greater islands; and, ultimately, the Malayan population occupied the whole of these islands, so far as their coasts were concerned, except a small portion on the northeast of Luzon. That is the only part of the coast to-day occupied by the Negritos or blacks; and the reason they have been allowed to occupy it is, that it affords very few harbors and is particularly subject to violent and destructive tempests; so that it was not much visited by the seafarers, either of Mongolian or Malayan blood.

You will see, therefore, that out of the 6,000,000 total inhabitants, considerably over five and a half million, certainly, are of Malayan descent, all of them speaking languages which are directly derived from the great Malayan family. They are what we call monoglottic; but that does not, by any means, signify that if you knew any one of those languages you would know the others. They differ so widely among themselves that one is unintelligible to the other, to a very great extent; and the Spanish government has officially recognized, in its proceedings and in its courts, the existence of thirty-five different languages (each unintelligible to the other) on this archipelago; and the latest classification of the Malayan inhabitants alone places the dialects at fifty-one or fifty-two.

Linguistic difficulties of a very serious character thus arise at once, in any consideration of the consolidation of the interests of these peoples. The Negritos are nearly all in a complete state of barbarism or savagery; they have no settled abodes; they do not till the soil; they wander about from place to place; and they do not love to meet either the Malayan or the white. They are shy, and seek the obscurity of the tropical alphabet that was in vogue about 300 to 400 B. C. in India; and it is noteworthy as indicating the origin of this alphabet, that wherever we find it in a Malay population, the language of that Malay population indicates a decided percentage of Sanskrit words.

The Malay population throughout the whole of this large archipelago may be grouped, for convenience of study, into four different divisions. We have the mixed tribes of northern Luzon, the Tagals and the Bicols (who are very similar to the Tagals), and throughout the whole of the central archipelago we have the Bisayas. They extend to the northern part of Mindanao, but the southern portion of Mindanao, and the Sulu Islands, are peopled by the Moros, or Moors.

I will now refer briefly to the tribes in northern Luzon. They are very numerous, of various names, and often only in part converted or reduced by the Spanish power. Those that have not been, live in a state almost of nature, cultivating the soil to some extent, but depending also largely upon the natural fruits. They have not, by any means, all been converted to Christianity; some of them are still pagan or heathen. The character of their religion may be seen somewhat from two of their gods which are represented here, a male and a female, from a tribe in central northern Luzon. The name of the female divinity is Busi, which means, in their language, "Life." The character of their arms is seen in the shield. They are still in quite a wild condition; nevertheless, they live together in hamlets and are under the form of government which is generally known to ethnologists as "Patriarchal;" that is to say, that some man, a senior in the village, has charge of all the law which is to be carried out. He is the head man. He is in some degree elective; but he is frequently also hereditary. They have some peculiarities in carrying out their theory of law which would strike us as a little singular, but are very practical. One of them is the ordeal through which they pass those who are suspected of being thieves. When a man loses a knife, or a gun, or a saber, he goes to the head man and tells him of his loss assonance of the vowels, without reference to the quantity of the vowel, so it is of the same character. They have many farms and plantations; they are industrious; they are those who furnish most of the material that we import; they raise tobacco; they are very much given to a few habits and customs to us somewhat displeasing: chewing the betel nut (the Areca nut); smoking—men, women, and children, indiscriminately, at all times and to any extent; and also their greatest pleasure is cock fighting. There are probably no more devoted cock fighters in the world than the Manilans; and yet I understand that under the present government of Aguinaldo it has been prohibited; though up to a few months ago it was certainly their chief pleasure. Physically, they are distinctly of a Malay type, brown in color, varying in shade from a dark to a light brown, with straight black hair, black eyes, medium stature, the lips rather full and heavy, the nose peculiar in character, with a very low bridge and very prominent nostrils, so that really some of them look as if their nose was reduced to two holes in their face; and also a peculiar droop to the inner portion of the eye.

Their native religion is now almost done away with, except in remote parts and some of the smaller islands. By some it is considered to be a degraded form of Buddhism; by others it is supposed to be nature worship. They have a chief god called Batala, and this word is said by some writers to be a form of Buddha. I am not able myself to solve a problem of this difficult character; but certain it is, that we do find traces of Buddhism, very ancient in character, throughout certain portions of the archipelago. These Tagalas stand at the head, not only of the Malayan population of the Philippines, but of the Malayans anywhere in the world, and they represent the best class of Malayan character. I regret to say that almost all literature gives an unfavorable opinion upon that character. The Malayan everywhere is looked upon as industrious, to be sure, eager for gain; very willing to work if he is well and regularly paid, but treacherous, having no very deep emotions except those of revenge; forgetting

benefits, but remembering slights and injuries; given to violent outbreaks of temper—doing that which we all know as "running amuck"—yielding himself up blindly to his passion for destruction. It may well be said, however, that these unfavorable elements of character have been exaggerated, if they have not been actually created, by the unfortunate governmental and social conditions under which they have suffered.

The Visayas inhabit the central islands, and were originally quite as highly developed as the Tagals; but they have lost that in recent years, and now we find in the island of Panay some of the most desperate characters in the whole archipelago. You have read from time to time of a little town called Iloilo, which is in the southern portion of Panay. It is a rather strongly fortified Spanish post, and it has been regarded, for the last few generations, as a sort of Coventry, to which were sent Spanish officers who were not in very good favor.

The island of Mindanao, about the size of Ohio, is partly unexplored in its interior. There are large tracts occupied there by people in an aboriginal condition, mostly of Malayan blood or crossed Malayan with Negrito blood. The whole of the peninsula is occupied by Sibunas, except it is the extreme southern portion by the Moros, which is, also, partly unexplored.

The Moros are the Mohammedan population of the Philippines. Their ancestors came about the fourteenth century from northern Borneo and were an advance of the great propaganda of Islam coming from Arabia. Many of them were Semites of Arabic blood. They brought with them the Koran, and they established in the Sulu Islands a great school, which, for several centuries, was looked upon as the "Mecca of the East" (as it was called), on account of the able priests who grew up there and taught their doctrines throughout the whole of the southern archipelago. They are grouped together under sultanates and princes, and they have the most positive and definite form of government of any of the inhabitants of the Philippine Islands. They have been notorious as pirates, slave catchers, and slave dealers, and it is only within the last few years that their piratical excursions have been limited and lessened; but at no time has Spain conquered these Moros. Dr. Baesler, a German physician, was visiting there eight or nine years ago, before this insurrection broke out, of which we have recently heard so much; he visited the Sulu Islands and says that "Nowhere among them at that time did the Spaniard dare to go outside of the range of the guns of his own fortress; if he did so, he never returned;" and at that time they considered the islands in a state of profound peace. Therefore, it is quite possible that, up to the present day, the true Moors of the Sulu Islands have never acknowledged the suzerainty of any government whatever. They speak a dialect in which Arabic words are largely infused; and they still continue a fanatical adherence to most of the decrees of the Koran; but yet Dr. Baesler and other travelers say that they are not averse to the juice of the grape nor even to the flesh of the accursed swine when it is offered to them in a seasonable manner. It is likely, therefore, that the stringency of their doctrines has been somewhat marred and weakened by the distance from the Holy City.

These are the principal races and tribes who inhabit this vast archipelago. I have not mentioned in detail those who live, for instance, on Palavan, who also are Malays, small in size, dark in color, absolutely savage, and unconverted from their pagan rites. On the islands—the Calamianes, Leyte, and Samar—we find a rather highly cultivated series of peoples belonging to the Bisayas group, of whose character I have already spoken.

Let us see to what extent the missionaries have carried their religion in the Philippine Islands. They have reduced to writing and have published dictionaries and grammars in six of the languages and the principal dialects of Luzon. The Catholic religion extends along the western coast of Luzon, and throughout the whole of southern central Luzon, the Tagals, and the Bicols, are all pretty good Catholics. Mindoro, where there is a large Malay population, has never been converted. The Bisayas, as a rule, have been converted and have become nominally attached to the Christian church. Throughout Mindanao very little has been done indeed. There are settlements on the northeastern portion, but the Subanas and the Manobas have remained unconverted. Very little has been done with the Moros, who, like all Mohammedans, stringently oppose the Christian religion; and, being very intelligent and well read in the Koran, they are able to maintain their own in a contest. The Ibanacs have been converted. We have dictionaries in the Ibanac and in the Iloca, which is spoken in northwest Luzon, and in all of those are printed dictionaries, grammars, and works of devotion.

The subject of the ethnography of the Philippines has been carefully studied by several German and several French writers. The French writer who has done the most is Monsieur Montano, who was sent by the French government about fifteen years ago to make an excursion for mercantile purposes. His work is the best for anthropology and ethnology. He published a number of ethnographic views of the land and of its people. There was also a French commercial traveler, Artur Marché, who published several valuable articles on these remote tribes. The great German writer on this subject is Prof. Blumentritt, of Saxony, who has written the best work (it is now, perhaps, a little old, being published in 1881) on the "Ethnography of the Philippines," very good up to that time, but written in a style very difficult to read. There was a German druggist who lived at Manila (dying about two years ago), Adrian Schadenberg, who, in his leisure times, made a study, going off on his vacations to the least known of the tribes of the Philippine Archipelago, and who usually would write out an article and send it to Berlin, where it would be printed, usually by the Berlin Anthropological Society there, sometimes by the Geographical Society. He never published a book, but these scattered reports are the very best I have found, being written in a simple style from a competent man's observations. There are, of course, a large number of Spanish books upon the subject; but I regret to say the Spanish writers are very unsatisfactory as scientific men. We have one by Paterno (whose name you may have seen in this evening's paper), who is a half Tagalian, born and brought up in the Philippines, and educated at Salamanca, in Spain, and has written four or five books on the subject which cover a great many facts. Pardo de Tavera, a man of some considerable ability (whose name appears in the papers from time to time) has written and published (generally privately) quite a number of monographs on single topics referring to the ethnology of the Philippines. Those are the few writers whom I recall at the present moment, but most of the literature in reference to the Philippines (its ethnology, at any rate) is scattered about in books difficult to obtain, some of them privately printed, or in journals, or in the proceedings of learned societies; so that it is not an easy task to obtain all the material you want without spending a good deal more time on it than most men are willing to give.

With regard to any sign language or common language throughout the Philippines, there is absolutely none whatever; so that, in the case of the druggist Schadenberg, when he wanted to make a journey to the headwaters of the Tago River of Luzon, he had to make his own vocabulary in six different dialects; and as he found it very useful for himself, he printed them in one of his papers, and on comparing them you would see at once that no one of these dialects would be intelligible to another. There is no common language, and that is one of the great difficulties that we would have to encounter in the Philippines. There is no common script. The script to which I refer differs considerably in the different islands; although it is all derived from one original source, yet it differs as much as the German letters from our letters and our letters do from the Greek letters, all three of these being directly derived from the one common source.

To meet the necessities of commerce at the seaports, the nearest toward any common language is the Tagala, which is spoken at Manila. All through that part of the ocean you will find "Manila boys" (so called) who are seamen who have been brought up in different parts of the archipelago and who go to Manila in order to get employment on the ships. They have to have some sort of a tongue by which they can make themselves understood, and there is a sort of a Lingua Franca which is a mixture of Spanish and Tagala—rather more Tagala than Spanish. It is rude; it is not a literary tongue; it is not that in which you will find any books or dictionaries; but it is a lingo such as you have in the Mediterranean, in the Lingua Franca.

Has Spanish been to any considerable extent learned by the natives and used by them? All the intelligent and educated natives can speak some Spanish; they are all generally very proud of it and consider it a very fine thing. They speak it badly. The missionaries have found it to their advantage, in teaching their converts, to use their native tongues, and that has, of course, perpetuated these throughout the islands. Spanish would not be known outside of a range of what we might call the suburbs of Manila; that is to say, within twenty-five or thirty miles. Beyond that you find very few people except the Pinols who know any Spanish, and in many parts of the islands and in many islands there practically would not be a dozen people who could speak Spanish fluently at all—a few interpreters; and only those others who have been obliged to speak it have learned it about Manila.

What is the explanation of the fact that in America, which was colonized by the Spaniards at about the same time as the Philippines, Spanish very rapidly became the language of the people, while in these islands it does not seem to have made very much headway in several centuries? The explanation is largely historic. In America it was found necessary, in their extensive journeys of exploration and conquest, that there should be some common tongue; but it was not through the efforts of the missionaries that Spanish was taught to the natives; it was through the Spanish officials forcing them.

There was not the same pressure of necessity in the Philippine Islands. It is hardly correct to say that Spanish is at all generally known among the native inhabitants of Mexico or Central America. I am informed by those who have visited many of the villages whose inhabitants for now three hundred years and more have been converted, that you will frequently find only one or two people in the whole village who can speak any Spanish, as, for instance, in Jalisco, Chiapas, and southern Mexico. The same principle has been carried out there as elsewhere—that it is wiser to teach the natives in their own tongue. That plan has prevailed among all Christians who have undertaken foreign missions. They have sought to learn the language and then teach the principles of religion in the language of the people; but it seems to have been somewhat more difficult in the Philippine Islands on account of the very great variety of dialects of the Malayan that is there spoken; therefore, there has been no settled attempt to teach Spanish; and, indeed, I remember one authority that says it was distinctly frowned upon. It was thought not desirable that the natives should learn any one language in common, on account of the increased liability that they would unite in an insurrection, and it was thought, therefore, good policy to keep them separated by tongues which were their own.

The tendency of the Malayan is decidedly to gain, and it is the strongest feature of his character by which he could be lifted toward a fixed and higher civilization. The casus belli—their great point of complaint—has been, hitherto, that they were not allowed to keep the money that they made, or to make the money that they could; and that is perfectly true under the Spanish régime. They have been constantly annoyed by excessive taxation and by prohibition—that they should raise this or should not raise that. I believe, if it was properly appealed to, that this intense desire to accumulate property, which is a marked trait of the Malayan everywhere, could be made a powerful lever toward lifting him up to a more complete civilization. Up to the present it has been largely from the vicinity of Manila and from the central and southern part of Luzon that the articles of export have been derived. There are also some extensive populations of an agricultural character on the northeastern portion of Mindanao, where the land is very fertile and the coast affords some pretty good harbors. Samar has been cultivated tolerably well; Panay has had an important trade also, but at present is in a state of utter insurrection which prevents trade. Mindoro seems never to have been brought under complete cultivation or subjection. The people are wild and warlike. Throughout the whole of the Moros Islands the people care very little for agriculture, although what the Germans call "Die Deutsche Borneo-Geselschaft" (which is a large trading company whose stock is owned by Germans) have one of their principal stations in the island near the little town of Jolo, where is located a Spanish fortress; and it is a very important point, in view of the productions of this island, that they can obtain the same, for the company's agents do it at the risk of their lives constantly.

What are the mineral resources? The Spaniards, for reasons best known to themselves, positively prohibit the examination or exploitation of the mineral resources. They have, on several occasions, prevented geologists from German societies who wished to explore the mountains from doing so. It is no doubt true, however, that the auriferous gravels there are exceedingly rich in many places. One man, whom I remember to have spoken of the subject, said that there is scarcely a stream in northern Luzon that you cannot wash the gold from its sands in sufficient quantities to make it, as the Westerners say, "pay dirt;" and if that is the case, the auriferous deposits are no doubt quite important. There is also coal and, about the volcanoes, sulphur, in such abundance that it has been made a matter of export. The coal lands, while they are there, have never been utilized. They are probably soft coal, as the whole formation is quite modern; but nothing has been done looking toward a development of the mineral resources.

TRAITS OF THE ALLIGATOR.

The alligator is rapidly disappearing in the settled regions of Florida, and becoming scarcer every day even in such remote regions as the Everglades, owing to the war of extermination waged against it by hide hunters, taxidermists, and dealers in curiosities. These pursue it night and day, year in and year out. The little fingerlings just out of the nest are in great demand, as they are worth from two to three dollars per hundred in the local markets. The "curio" dealers who purchase them often resell them at a dollar each to Northern visitors, or else they kill and stuff them into card plates, cigar holders, or whatever else their fancy suggests, and dispose of them at good prices. The young are frequently lured from their lurking places by a poor imitation of the grunts of their mother, and men expert in mimicking her may capture a large number in a day, as they respond promptly to the calls, and pour out of cavities in hot haste to see the caller. The most expert "'gator callers" I ever knew were swamp rangers, both white and black, who were born and bred within a short distance of an alligator swamp, and therefore knew every intonation of the saurian's voice. These men could make a matron charge wildly at them across a broad stream by imitating the frightened cries of her young or lure a decrepit old bull by mimicking the grunts of the female. They could, in fact, delude both old and young, and often earned good sums by their art.

The "bellowing season" begins in May and lasts until the middle of July, and during that time the unmated bulls make night hideous. In fighting each other, they use jaw and tail with the utmost fury. They must deliver exceedingly heavy blows with the latter, for the sounds can be heard at a considerable distance. When one gets a good mouth hold on the other, it clings like a bulldog; but as the body armor is generally tooth-proof, except in special places, little damage can be done even in a protracted conflict. As the reptiles can only deliver blows at objects a little to one side of the head, it is amusing to see them try to get directly in front of each other, and make circular sweeps with the tail in the blind hope that some may prove effective. I have known them to fight for hours, at intervals, with great fury, and have again seen a huge bull retreat in a most demoralized manner after receiving a few blows. If they fight in the water, they can apparently sustain it for days, if evenly matched, because they seldom retreat, and seem to stop only because they are tired of thrashing the fluid.

When the female is ready to lay her eggs she retires to some secluded wet or swampy place and builds, out of mud, decayed vegetation, and rushes, a nest two feet or three feet high, and having a large, firm base. If she builds on tide water, she carries her nest further back (some years more than others), as if she knew when tides would be unusually high; and the strangest part of it is that, as a rule, "high nests and high tides" go together. This would seem to imply a prophetic instinct, and some strangers and alligator hunters think she possesses it in an unusual degree. The receptacle for the eggs is deep and spacious and well made. She lays from 20 to 100 eggs in this, usually in July, covering them with light, loose material to give the young, when hatched, plenty of room, and makes the upper part solid by beating it with her head and walking over it several times to trample it down. She frequently walks over it while the eggs are incubating, in order to keep it packed, for, if it became loose, the rain would enter and prevent the eggs from hatching.

It usually takes sixty days for the young to appear, and she evidently knows the hour they should announce their presence, for she keeps passing around the nest the day when they are expected, becomes nervous, unusually irritable, and so pugnacious that she is ready to fight anything from a mole to a man that approaches her nursery. On hearing the young give their first faint croak, she begins tearing away the covering with claws and jaws, and on reaching them gives several endearing grunts, then proudly leads them to her cave in the swamp, stream, or lake close by. From that moment forward she must vigilantly watch her progeny to prevent them from being destroyed by enemies, for everything that eats flesh seems to prey upon them. Fishes, snakes, owls, hawks, polecats, and turtles devour them whenever they can, but their worst foes are the bull alligators, for they destroy them out of mere wantonness. They sometimes tear nests open on hearing the youngsters croaking, and eat everyone before the mother can come to their rescue. The latter is so vigilant that this seldom happens, yet it is frequent enough to make matrons and bulls deadly enemies during the incubating season. The latter run with all speed from a nest on seeing the

female approaching, and get as far away as possible—the quickest time they can make.

One of the peculiarities of the eggs of an alligator is that they are generally of different shapes, although the ends are always alike. They are about one inch and a half in diameter, and the ordinary length of the newly hatched youngsters is four inches. These do not eat any food for several days after leaving the nest, and make a beginning on larvæ, water insects, and frogs, gradually advancing to snakes, fishes, and, finally, to anything edible. They cannot eat food that requires tearing apart, owing to the bluntness and irregularity of their teeth. An adult saurian possesses eighty teeth, if it has not lost any by accident, and no two are of the same size and shape except those opposite each other. That is why it cannot tear fresh flesh, and must allow it to putrefy before it can be eaten. The teeth are hollow, yet strong, and are shed every year, so that the loss of a few in a contest produces no permanent injury. Both old and young catch their prey by lying in wait for it, and striking it suddenly with the tail when it approaches near enough to be hit. Mouth and tail work automatically together, for the caudal blow promptly knocks the prey into the distended, awaiting jaws. That given, the saurian backs off into deep water and begins rolling over and over like a barrel, or spinning round and round in a circle for the purpose of suffocating its captive as speedily as possible. It then takes its prey to some favorite retreat and buries it until it becomes tender enough, through putrefaction, to be easily torn apart. This rolling habit is so pronounced a trait that an alligator struck with a harpoon will roll over and over on the line until it is all tangled up; or it will coil the painter of a boat around itself until the craft is ready to sink, unless the rope is cut.—Popular Science News.

DIETARY STUDIES.

PROFESSOR W. O. Atwater and Mr. C. D. Woods have published, through the Department of Agriculture, interesting studies of the diets of families living in a congested portion of New York city, together with studies at a mission and a day nursery in the same region. The abstract of their 117 page paper in the Experiment Station Record states that the families were selected as typical of the so-called poor classes usually encountered by philanthropists and mission workers in the congested districts of large cities.

Tables are given showing the kind and amount of food purchased, wasted, and eaten, and its cost, composition, and fuel value. The results are briefly summarized as follows:

Results of dietary studies—cost and composition of food eaten per person per day.

	Cost.	Protein.	Fat.	Carbohydrates.	Fuel Value.
	Cents.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Mechanic's family	31	149	128	526	3,955
Carpenter's family	23	148	144	458	3,825
Jeweler's family	18	99	104	296	2,595
Sailor's family	26	139	143	558	4,170
Watchman's family	13	84	92	292	2,400
Carpet dyer's family	16	71	93	310	2,430
Family of carver in a restaurant	13	85	88	261	2,235
Sailors' boarding house	17	95	125	181	2,295
Truckman's family	22	100	129	325	2,935
Sewing woman's family	9	54	41	219	1,500
Shopkeeper's family	15	80	109	351	2,780
Housekeeper's (widow) family	18	93	104	509	3,435
Laborer's family	23	139	119	345	3,090
Porter's family	28	142	142	444	3,720
Printer's family	22	116	124	364	3,120
Truckman's family	22	136	135	595	4,250
Family of caretaker at a day nursery	23	122	158	394	3,585
Builder's family	41	187	219	723	5,770
Do	42	204	264	714	6,220
Salesman's family	16	79	125	347	2,910
Tin roofer's family	20	99	123	327	2,910
Do	16	84	114	227	2,335
Family at a mission	37	143	205	545	4,725
Children at a day nursery (per child per day)	4	30	20	120	800

From the data available the authors do not feel justified in drawing specific deductions. Some general suggestions for the improvement of the dietaries are, however, made. By the selection of cheaper though equally nutritious articles of food, it would, as a rule, have been possible to supply a more nutritious diet at less cost. In many instances, while the foods chosen were inexpensive, they were of such a character that they contained a small percentage of nutrients. Purchasing in quantity, where possible, would also have diminished the cost. Some of the families studied had a sufficient income to enable them to live comfortably if care had been exercised in its expenditure. The authors believe that permanent improvement must come through education. The people must be taught to select food wisely, and to cook it and serve it in an acceptable manner.

Calculated amount and cost of nutrients consumed per person daily.

	Number of persons fed.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
		Cents.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
South Boston House of Correction	523	9.89	153	78	501	3,406
Deer Island House of Correction	1,754	7.34	122	69	624	3,700
Rainsford Island House of Reformation	125	8.07	103	60	414	2,677
Parental School	125	5.29	70	40	346	2,078
Marcella Street Home	333	8.37	95	55	380	2,459
Long Island Almshouse and Hospital	833	7.73	109	48	554	3,164
Charlestown Almshouse and Hospital	145	7.54	71	72	355	2,415
Austin Farm (inmates and employees)	375	12.94	110	114	449	3,327
Pierce Farm (inmates and employees)	194	18.85	138	180	471	4,171

With these results may be compared the report on the dietaries of nine institutions of the city of Boston compiled by Ellen H. Richards and Sarah E. Wentworth (Institutions Comm., Boston, Rpt., 1896, pp. 206–219). On the basis of raw materials furnished and number of persons fed the above data were secured.—Science.

CONTINUITY OF WAVE THEORIES.*

CONSIDER the following three analogous cases: I. Mechanical; II. Electrical; III. Electromagnetic.

I. Imagine an ideally rigid globe of solid platinum of 12 centimeters diameter, hung inside an ideal rigid massless spherical shell of 13 centimeters internal diameter, and of any convenient thickness. Let this shell be hung in air or under water by a very long cord, or let it be embedded in a great block of glass, or rock, or other elastic solid, electrically conductive or non-conductive, transparent or non-transparent for light.

I. (1) By proper application of force between the shell and the nucleus cause the shell and nucleus to vibrate in opposite directions with simple harmonic motion through a relative total range of 10^{-3} of a centimeter. We shall first suppose the shell to be in air. In this case, because of the small density of air compared with that of platinum, the relative total range will be practically that of the shell, and the nucleus may be considered as almost absolutely fixed. If the period is $\frac{1}{32}$ of a second, frequency 32 according to Lord Rayleigh's designation, a humming sound will be heard, certainly not excessively loud, but probably amply audible to an ear within a meter or half a meter of the shell. Increase the frequency to 256, and a very loud sound of the well known musical character (C_{256}) will be heard.†

Increase the freqency now to 32 times this, that is to 8,192 periods per second, and an exceedingly loud note 5 octaves higher will be heard. It may be too loud a shriek to be tolerable; if so, diminish the range till the sound is not too loud. Increase the frequency now successively according to the ratios of the diatonic scale, and the well known musical notes will be each clearly and perfectly perceived through the whole of this octave. To some or all ears the musical notes will still be clear up to the G (24,756 periods per second) of the octave above, but we do not know from experience what kind of sound the ear would perceive for higher frequencies than 25,000. We can scarcely believe that it would hear nothing, if the amplitude of the motion is suitable.

To produce such relative motions of shell and nucleus as we have been considering, whether the shell is embedded in air, or water, or glass, or rock, or metal, a certain amount of work, not extravagantly great, must be done to supply the energy for the waves (both condensational and rarefactional), which are caused to proceed outward in all directions. Suppose now, for example, we find how much work per second is required to maintain vibration with a frequency of 1,000 periods per second, through total relative motion of 10^{-3} of a centimeter.

Keeping to the same rate of doing work, raise the frequency to 10^4, 10^5, 10^6, 10^9, 10^{12}, 500×10^{12}. We now hear nothing and we see nothing from any point of view in the line of the vibration of the center of the shell which I shall call the axial line. But from all points of view, not in this line, we see a luminous point of homogeneous polarized yellow light, as it were in the center of the shell, with increasing brilliance as we pass from any point of the axial line to the equatorial plane, keeping at equal distances from the center. The line of vibration is everywhere in the meridional plane, and perpendicular to the line drawn to the center.

* "Continuity in undulatory theory of condensational-rarefactional waves in gases, liquids, and solids, of distortional waves in solids, of electric waves in all substances capable of transmitting them, and of radiant heat, visible light, ultra-violet light." Communicated by Lord Kelvin, G.C.V.O., being the substance of a communication to Section A of the British Association at its recent meeting in Bristol.

† Lord Rayleigh has found that with freqency 256, periodic condensation and rarefaction of the marvelously small amount 6×10^{-9} of an atmosphere, or "addition and subtraction of densities far less than those to be found in our highest vacua," gives a perfectly audible sound. The amplitude of the aerial vibration, on each side of zero, corresponding to this is $1{\cdot}27 \times 10^{-7}$ of a centimeter.—"Sound," vol. ii., p. 439 (second edition).

When the vibrating shell is surrounded by air, or water, or other fluid, and when the vibrations are of moderate frequency, or of anything less than a few hundred thousand periods per second, the waves proceeding outward are condensational-rarefactional, with zero of alternate condensation and rarefaction at every point of the equatorial plane and maximum in the axial line. When the vibrating shell is embedded in an elastic solid extending to vast distances in all directions from it, two sets of waves, distortional and condensational-rarefactional, according respectively to the two descriptions which have been before us, proceed outward with different velocities, that of the former essentially less than that of the latter in all known elastic solids.* Each of these propagational velocities is certainly independent of the frequency up to 10^4, 10^5, or 10^6, and probably up to any frequency not so high but that the wave length is a large multiple of the distance from molecule to molecule of the solid. When we rise to frequencies of 4×10^{12}, 400×10^{12}, 800×10^{12}, and $3{,}000 \times 10^{12}$, corresponding to the already known range of long period invisible radiant heat, of visible light, and of ultra-violet light, what becomes of the condensational-rarefactional waves which we have been considering? How and about what range do we pass from the propagational velocities of 3 kilometers per second for distortional waves in glass, or 5 kilometers per second for the condensational waves in glass, to the 200,000 kilometers per second for light in glass, and, perhaps, no condensational wave? Of one thing we may be quite sure; the transition is continuous. Is it probable (if ether is absolutely incompressible, it is certainly possible) that the condensational-rarefactional wave becomes less and less with frequencies of from 10^6 to 4×10^{12}, and that there is absolutely none of it for periodic disturbances of frequencies of from 4×10^{12} to $3{,}000 \times 10^{12}$? There is nothing unnatural or fruitlessly ideal in our ideal shell, and in giving it so high a frequency as the 500×10^{12} of yellow light. It is absolutely certain that there is a definite dynamical theory for waves of light, to be enriched, not abolished, by electromagnetic theory; and it is interesting to find one certain line of transition from our distortional waves in glass, or metal, or rock, to our still better known waves of light.

I. (2) Here is another still simpler transition from the distortional waves in an elastic solid to waves of light. Still think of our massless rigid spherical shell, 13 centimeters internal diameter, with our solid globe of platinum, 12 centimeters diameter, hung in its interior. Instead of as formerly applying simple forces to produce to-and-fro rectilinear vibrations of shell and nucleus, apply now a proper mutual forcive between shell and nucleus to give them oscillatory rotations in contrary directions. If the shell is hung in air or water, we should have a propagation outward of disturbance due to viscosity, very interesting in itself; but we should have no motion that we know of appropriate to our present subject until we rise to frequencies of 10^9, 10×10^{12}, 400×12^{12}, 800×10^{12}, or $3{,}000 \times 10^{12}$, when we should have radiant heat, or visible light, or ultra-violet light proceeding from the outer surface of the shell, as it were from a point-source of light at the center, with a character of polarization which we shall thoroughly consider a little later. But now let our massless shell be embedded far in the interior of a vast mass of glass, or metal, or rock, or of any homogeneous elastic solid, firmly attached to it all round, so that neither splitting away nor tangential slip shall be possible. Purely distortional waves will spread out in all directions except the axial. Suppose, to fix our ideas, we begin with vibrations of one second period, and let the elastic solid be either glass or iron. At distances of hundreds of kilometers (that is to say, distances great in comparison with the wave length and great in comparison with the radius of the shell) the wave length will be approximately 3 kilometers.† Increase the frequency now to 1,000 periods per second; at distances of hundreds of meters the wave length will be about 3 meters. Increase now the frequency to 10^6 periods per second; the wave length will be 3 millimeters, and this not only at distances of several times the radius of the shell, but throughout the elastic medium from close to the outer surface of the shell; because the wave length now is a small fraction of the radius of the shell. Increase the frequency further to $1{,}000 \times 10^6$ periods per second; the wave length will be 3×10^{-3} of a millimeter, or 3 mikroms,‡ if, as in all probability is the case, the distance between the centers of contiguous molecules in glass and in iron is less than a five-hundredth of a mikrom. But it is probable that the distance between centers of contiguous molecules in glass and in iron is greater than 10^{-5} of a mikrom, and therefore it is probable that neither of these solids can transmit waves of distortional motion of their own ponderable matter of so short a wave length as 10^{-5} of a mikrom. Hence it is probable that if we increase the frequency of the rotational vibrations of our shell to one hundred thousand times $1{,}000 \times 10^6$, that is to say, to 100×10^{12}, no distortional wave of motion of the ponderable matter can be transmitted outward; but it seems quite certain that distortional waves of radiant heat in ether will be produced close to the boundary of the vibrating shell, although it is also probable that if the surrounding solid is either glass or iron, these waves will not be transmitted far outward, but will be absorbed, that is to say, converted into non-undulatory thermal motions, within a few mikroms of their origin.

Lastly, suppose the elastic solid around our oscillating shell to be a concentric spherical shell of homoge-

* "Math. and Phys. Papers," vol. iii., art. civ., p. 522.

† "Math. and Phys. Papers," vol. iii., art. civ., p. 522.

‡ For a small unit of length Langley, fourteen years ago, used with great advantage and convenience the word "mikron" to denote the millionth of a meter. The letter n has no place in the metrical system, and I venture to suggest a change of spelling to "mikrom" for the millionth of a meter, after the analogy of the English usage for millionths (mikrohm, mikroampere, mikrovolt). For a conveniently small corresponding unit of time I further venture to suggest "michron" to denote the period of vibration of light whose wave length in ether is 1 mikrom. Thus, the velocity of light in ether being 3×10^8 meters per second, the michron is $\frac{1}{3} \times 10^{-14}$ of a second, and the velocity of light is 1 mikrom of space per michron of time. Thus the frequency of the highest ultra-violet light investigated by Schumann (0·1 of a mikrom wave length, Sitzungsber. d. k. Gesellsch. d. Wissensch. zu Wien, cii., pp. 415 and 625, 1893) is ten periods per michron of time. The period of sodium light (mean of lines D) is 0·589212 of a michron; the periods of the "Reststrahlen" of rocksalt and sylvin found by Rubens and Aschkinass (Wied. Ann., lxv., 1898, p. 241) are 51·2 and 61·1 michrons respectively.

No practical inconvenience can ever arise from any possible confusion, or momentary forgetfulness, in respect to the similarity of sound between michrons of time and mikroms of space.—K.

neous glass of a few centimeters, or a few meters, thickness and of refractive index 1·5 for D light. Let the frequency of the oscillations be increased to $5{\cdot}092 \times 10^{14}$ periods per second, or its period reduced to 0·589212 of a michron: homogeneous yellow light of period equal to the mean of the periods of the two sodium lines will be propagated outward through the glass with wave length of about $\frac{2}{3} \times 0{\cdot}589212$ of a mikrom and out from the glass into air with wave-length of 0·589212 of a mikrom. The light will be of maximum intensity in the equatorial plane and zero in either direction along the axis, and its plane of polarization will be everywhere the meridional plane. It is interesting to remark that the axis of rotation of the ether for this case coincides everywhere with the line of vibration of the ether in the case first considered; that is to say, in the case in which the shell vibrated to and fro in a straight line, instead of, as in the second case, rotating through an infinitesimal angle round the same line.

A full mathematical investigation of the motion of the elastic medium at all distances from the originating shell, for each of the cases of I. (1) and I. (2), will be found in a volume containing my Baltimore lectures on "Molecular Dynamics and the Wave-Theory of Light," soon, I hope, to be published.

II. An electrical analogy for I. (1) is presented by substituting for our massless shell an ideally rigid, infinitely massive shell of glass or other non-conductor of electricity, and for our massive platinum nucleus a massless non-conducting globe electrified with a given quantity of electricity. For simplicity we shall suppose our apparatus to be surrounded by air or ether. Vibrations to and fro in a straight line are to be maintained by force between shell and nucleus as in I. (1). Or, consider simply a fixed solid non-conducting globe coated with two circular caps of metal, leaving an equatorial non-conducting zone between them, and let thin wires from a distant alternate-current dynamo, or electrostatic inductor, give periodically varying opposite electrifications to the two caps. For moderate frequencies we have a periodic variation of electrostatic force in the air or ether surrounding the apparatus, which we can readily follow in imagination, and can measure by proper electrostatic measuring apparatus. Its phase, with moderate frequencies, is very exactly the same as that of the electric vibrator. Now suppose the frequency of the vibrator to be raised to several hundred million million periods per second. We shall have polarized light proceeding as if from an ideal point source at the center of the vibrator and answering fully to the description of I. (1). Does the phase of variation of the electrostatic force in the axial line outside the apparatus remain exactly the same as that of the vibrator? An affirmative answer to this question would mean that the velocity of propagation of electrostatic force is infinite. A negative answer would mean that there is a finite velocity of propagation for electrostatic force. This velocity, according to views regarding conceivable qualities of ether described in my article "On the Reflection and Refraction of Light" (Phil. Mag., vol. xxvi., 1888), might be greater than, equal to, or less than the velocity of light.

III. The shell and interior electrified non-conducting massless globe being the same as in II., let now a force be applied between shell and nucleus to produce rotational oscillations as in I. (2). When the frequency of the oscillations is moderate there will be no alteration of the electrostatic force and no perceptible magnetic force in the air or ether around our apparatus. Let now the frequency be raised to several hundred million million periods per second; we shall have visible polarized light proceeding as if from an ideal point-source at the center and answering fully to the description of the light of I. (2). The same result would be obtained by taking simply a fixed solid non-conducting globe and laying on wire on its surface approximately along the circumferences of equidistant circles of latitude, and by the use of a distant source (as in II.) sending an alternate current through this wire. In this case, while there is no manifestation of electrostatic force, there is strong alternating magnetic force, which in the space outside the globe is as if from an ideal infinitesimal magnet with alternating magnetization, placed at the center of the globe with its magnetic axis in our axial line.—Nature.

W. E. Curtis, the Washington correspondent of The Chicago Record, writes of a scheme of the Japanese government, ordering the destruction of the city of Teckcham, Formosa, and removal of all its inhabitants to a new location. The city is situated on the northwest coast of the island, and has been frequently subject to pestilence. In 1896 and 1897 plagues visited Teckcham with enormous fatality. This fact being called to the attention of the government, an investigation was ordered by sanitary experts, who reported that the city was built upon a swamp, whereupon an order was issued to the governor to select a new location as convenient to the old as possible, where the natural conditions were healthful. A new city was laid out, and each property holder in the old one was assigned a site that corresponded in area with that he occupied at Teckcham, and was given twelve months to remove his buildings and belongings. Sewers, railroads, and sidewalks, public buildings, water works, and all other public improvements were laid out by the government in the new city without expense to the people, but they were required to pay the cost of the removal of their own property. Most of the houses and other buildings in Teckcham are built of very light wooden material.

Bohemia is one of the most populous countries on the globe. Its climate is relatively cool, with rather severe winters. Therefore much fuel is used, and it is largely taken from the forests which cover the mountain sides. Yet, according to Consul Makin, at Reichenberg, after the many centuries during which these forests have furnished fuel and building material for a dense population, they retain nearly their primeval area. This is due to the forethought of the government in ordaining that as trees were cut down others should be planted to fill the vacancies. Vast stretches of dense forests cover the mountain slopes of this district. The wood is mostly pine. Trees are constantly being cut; but, wherever a clearing is made, small trees are planted the next spring.

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